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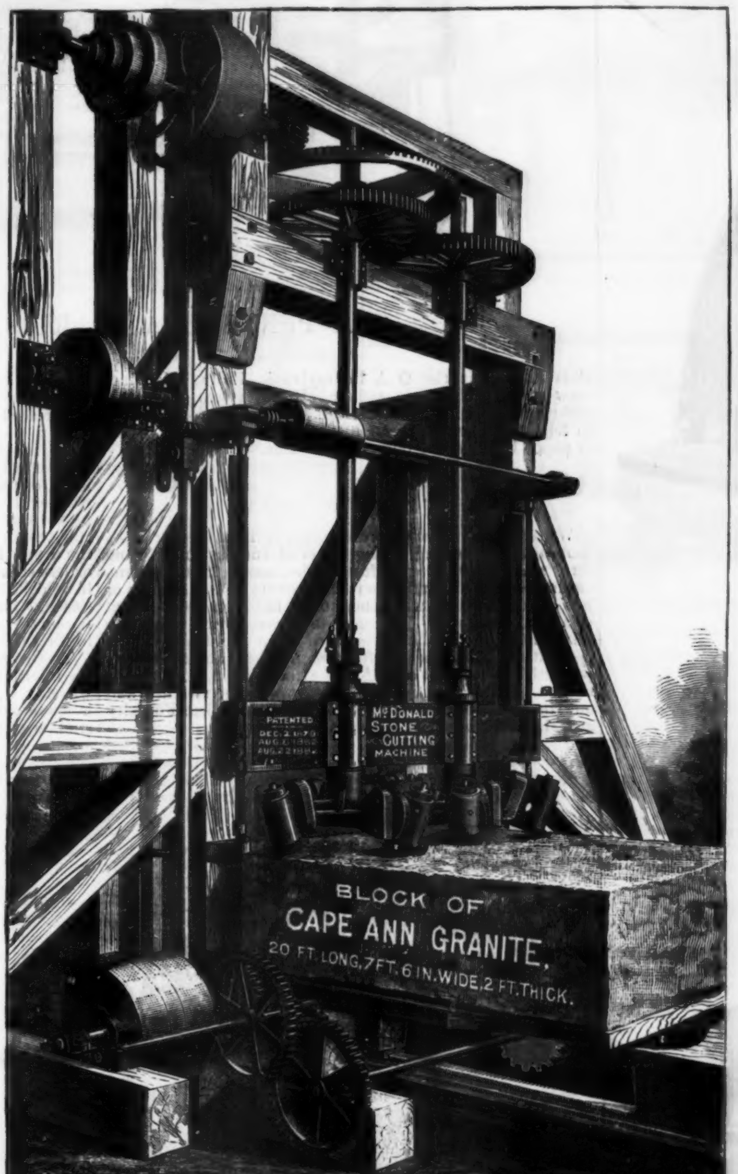
THE McDONALD STONE-CUTTING MACHINE.

THIS machine was especially invented to dress granite, but it will make rapid work in cutting flagging stone, freestone, sandstone, and squaring up blocks of marble. The cut shows two perpendicular shafts hung in a frame, the upper ends being provided with gears, by means of which the power is applied. At the lower ends of these shafts are four strong arms, to which are attached eight cylindrical cutter-carriers and cutters, which revolve right and left from the outside toward the center, where they slightly overlap and cut the stone as it passes under the machine. Each cutter is raised or depressed at will; can be set on an independent angle to accommodate its dimensions when new or partly worn. It can be set up and worked in a space 26 feet long, 16 feet wide, and 20 feet high, but more room is desirable. It stands independent of any building. The weight is about 28 tons, which includes frame and carriage. No single piece will exceed one ton weight. The usual speed is about 20 revolutions per minute. It cuts granite, either wet or dry, and makes but little noise or dust. One man tends the machine and grinds its cutters at the same time. The amount of power required is about eight-horse, according to the feed of carriage, width of stone, and hardness of material. A block of granite 18 feet long by 8 feet wide was recently cut with this machine by the Cape Ann Granite Co., which is six inches wider than the machine is expected to cut and leave a good arris. When cutting steps, or similar work, several pieces can be placed on the carriage at the same time. It will cut slabs less than four inches thick, and blocks of granite over 6 feet high. The feed of the carriage is from one to two inches each minute. For further information, address the McDonald Stone-cutting Machine Co., 18 Herald Building, Boston, Mass.



THE McDONALD STONE-CUTTING MACHINE.—[From a Photograph.]

LOADS AND STRAINS ON HOISTING ROPES.

MR. W. SILVER HALL, of Derby, England, writing to the *Engineer*, gives the following interesting facts, and makes suggestions which in many instances American engineers would do well to follow:

Some years since, I had a winding rope broken about three feet above the cap, in the act of raising the loaded cage from the props; in fact, the cage was raised and fell two and a half feet, as nearly as could be estimated. The weight of cage, tub, coal, and chains, with the cap and piece of broken rope, would be 75 or 76 cwt.; the weight of rope suspended in the shaft, 32 cwt.; total, 108 cwt. The rope was a flat one, of iron wire, tapering from 4¾ inches to 4¼ inches wide, giving a breaking strain of 60 tons and 50 tons, and a safe working load of 136 cwt. and 112 cwt. at the upper and lower ends respectively. It had only been in use a few weeks, and there was no sign of any flaw at the point of rupture. After the torn end was cut off, and the rope recapped, it continued to do its work satisfactorily for the full average life of the ropes at that pit. The engine, although a single-cylinder one, was remarkably easy to handle, and the engine-man one of the steadiest and most skillful that I have known. The rate of winding, though smart, was not excessive, the run of 202 yards being made in 30 seconds and the three-decked cage changed in 30 seconds; or, allowing for occasional delays, say, 55 runs per hour.

At first sight, the rope might have been expected to break at the top end, where the actual weight to be lifted was nearly 80 per cent. of the theoretical safe working load, rather than at the bottom end, where the weight was only 68 per cent. of the theoretical safe load; but when it is remembered that the 32 cwt. of rope is already in rapid ascending motion before the "snatch" comes to start the 76 cwt. of cage, etc., into motion, it is apparent not only that the rope actually did break where the severest strain came upon it, but also that that strain is very much nearer to the actual breaking strain than is commonly supposed.

A mere record of facts, such as the above, is not of much value unless it leads to the suggestion of some improvements in the appliances, or in the method of using them, calculated to obviate similar accidents in the future. One such suggestion, and the most obvious, is the substitution of steel for iron ropes, giving, with a rope of the same weight, an increased strength of some 50 per cent; but of course at a considerably increased cost. To employ a stronger and, consequently, heavier iron rope, would have the effect of striking an up-hand blow with a heavier hammer than before. Again, it is doubtful whether, for pits of moderate depth, the advantages obtained by a tapered rope are not purchased too dearly by the weakness at the bottom end, where, as we have already seen, the greatest strain comes at the moment of starting. Now, where the suspended weight of rope is counterbalanced by a tail rope—which, as I pointed out at the Leeds meeting of the Institution of Mechanical Engineers, in August last, can probably be economically applied in cases where the depth does not exceed 500 yards or thereabouts—the weight on the rope is constant at any stage of the winding and, consequently, a parallel rope is the right thing.

But perhaps the most important point of all is to diminish, as far as possible, the dead weight snatched at by the rapid starting of the engine, and this can only be done by using the lightest possible trams and cages. In the instance above given, if the cage had been of steel, instead of iron, its weight might probably have been reduced 30 per cent. or more—and I could point out instances where a much greater reduction has actually been effected—thereby reducing the total weight to be snatched at, that is, coal, tubs, cage, and chains, by about 12 per cent. But while cages are only too often considered as a convenient stock job, on which the colliery smith may advantageously employ the odds and ends of his time, and expend such bars of iron as he happens to have no other use for; while they are too often commenced, continued, and finished without any harmonious design or plan, but by the addition of one part after another, each fulfilling its own object, and adding to the total weight, but not contributing to the aggregate strength of the structure; while some of the parts most severely strained are too often weakened by injudiciously placed bolt or rivet holes, and when they fail are replaced by stouter bars and bigger rivets, the result can scarcely be satisfactory in any respect, and least of all where lightness is desired. Perhaps the next attempt is made in steel, with a result more disappointing than ever, and that ill-used material, as I have too often found when advocating its use, is for ever discredited in the eye of the disgusted proprietor.

As there is no difficulty in making a properly designed steel cage which for any given weight of coal to be lifted shall be from 25 to 50 per cent. lighter and shall cost no more than an iron one, it is surely time that the state of things which I have endeavored to describe, and which, as every mining inspector knows, is only too common, should cease to exist.

BRICK MANUFACTURE.

THE chief operations of brick making may be placed under the following heads: Preparation of brick earth or clay; tempering; moulding; drying; and burning.

The results to be attained by the practical brickmaker in making bricks suitable for building purposes are: Soundness, that is, freedom from cracks and flaws; hardness, to enable them to resist pressure and lateral strain; regularity of shape, so that the mortar or cement by which they are united may be of even thickness to insure uniformity of settlement; uniformity of size, that all the bricks in a course may be of the same height; similarity of color, which is only of importance in regard to the appearance of a building; and facility of cutting, to enable the workman to cut them to the various shapes required. For furnace work, and for all places where bricks are liable to be exposed to great heat, they require the additional quality of refractoriness or infusibility.

To accomplish these ends, the first and chief thing to be attended to is a proper selection of material, supplemented by a judicious preparation before commencing the actual process of brickmaking, as well as in the drying and burning of the bricks. The other operations are of secondary importance.

The argillaceous earths suitable for brickmaking may be divided into three principal classes:

First are the pure clays, commonly so called, composed chiefly of alumina and silica, but containing a small proportion of the other substances, such as iron, lime, magnesia, etc.

Secondly comes what are technically known as the marls, which are earths containing a considerable proportion of lime.

Thirdly, the loams, which may be regarded as light, sandy clays.

It does not often happen that earths are found which are suitable for brickmaking purposes without some admixture. The purer clays require the addition of sand, loam, or some milder earth; while the loams are often so loose that they could not be made into bricks without the addition of lime to flux and bind the earth. Even when the clay requires no mixture, the difference in the working of two adjacent strata in the same field is often so great that it is advisable to mix two or three sorts together to produce uniformity in the size and color of the bricks.

All brick clays have for their principal constituent a chemical compound of silica and alumina. This silicate of alumina, or pure clay alone, or those clays which contain but little sand, may, when beaten up with water into stiff paste, be moulded with great ease into any shape, but they will shrink and crack in drying, however carefully and slowly the operation be conducted. Neither will they stand burning, as a red heat causes the mass to rend and warp, although it becomes very hard by the action of the fire.

The addition of any substance that will neither combine with water nor is subject to contraction greatly remedies these defects, while the plastic quality of the clay is not materially affected. For this reason the strong clays are mixed with milder earth or with sand.

Refractory clays are compounds of silica, alumina, and water, and they owe their refractory qualities to their comparative freedom from lime, magnesia, metallic oxides, and similar substances, which act as fluxes. Few clays, however, exist in nature according to this pure type. Even in contiguous beds the relation between the silica and alumina is found to be extremely variable.

Bricks made of refractory clay, containing no lime or alkaline matter, are baked rather than burnt, and their soundness and hardness depend upon the fineness to which the clay has been ground and the degree of firing to which it has been exposed.

It is very seldom that common clays are found to be free from lime and other fluxes, and when these are present in

certain proportions, the silica of the clay becomes fused at a moderate heat and cements the mass together. Some earths are very fusible, and when used for brickmaking, great care is requisite in firing the bricks to prevent them from running together in the kiln.

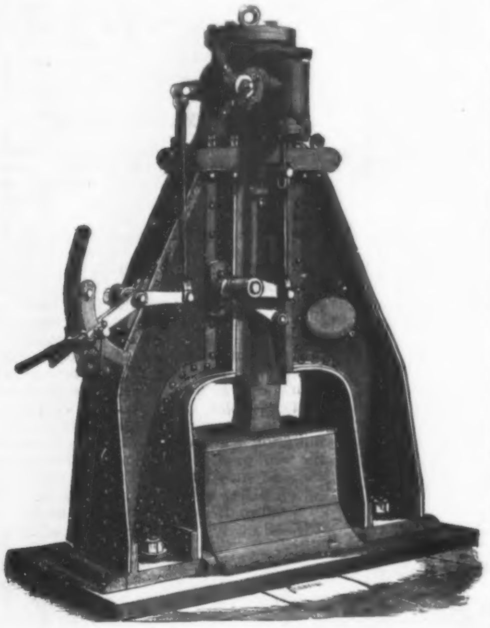
It will be seen from these remarks that we may divide bricks generally into two classes—baked bricks made from the refractory clays, and burnt or vitrified bricks made from the fusible earths.

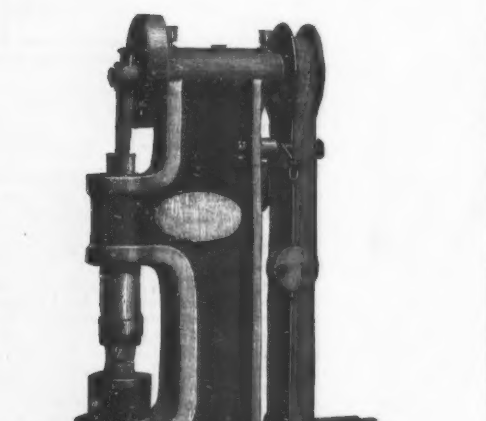
The fusible earths are the most difficult of treatment, as there is considerable practical difficulty in obtaining a sufficient degree of hardness without risking the fusion of the bricks; and it will be found that ordinary kiln-burnt bricks, made from the common clays, are for the most part of inferior quality, being hard only on the outside, while the middle is imperfectly burned and remains tender.

Bricks which will bear cutting and rubbing to any required shape are made from sandy loams, either natural or artificial. Bricks made from pure clays containing but little silica are hard and tough, and will not bear cutting.—*Glassware Reporter.*

STEAM AND PNEUMATIC HAMMERS.

At the Metal Trades Exhibition, London, held in the Agricultural Hall in July, Thwaites Brothers, of Bradford, Yorkshire, show, among other things, two very handy





TILT HAMMER AND PNEUMATIC POWER HAMMER.

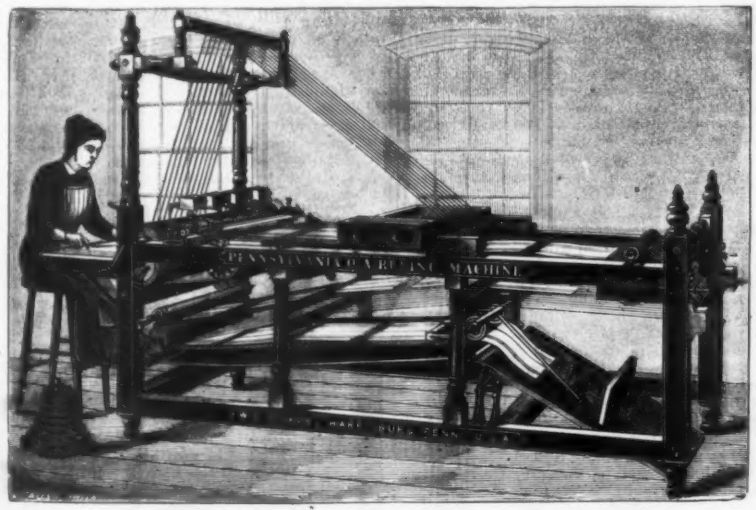
power hammers, one of 2 cwt., driven by steam, and the other a 50 lb. pneumatic hammer. These we illustrate from *Engineering.*

The standards of the steam hammer are built up of wrought iron plates firmly riveted together, and the guides, which are of cast steel, are riveted to the standards. The hammer head and piston rod are made of mild steel, the diameter of cylinder being 8 in. and the stroke 12 in. It has a quick, direct, self-acting valve motion, made of the best Yorkshire iron with large wearing surfaces made extra strong and case hardened. The anvil block and bed-plate are made in one piece. The hammer runs at a high speed and is used for tilting steel.

The 50 lb. pneumatic power hammer has been designed for use in a shop where a steam hammer cannot conveniently be employed. It is worked by a belt which hangs loosely on the pulleys when the hammer is not in action, but which, when required, can be tightened by a pressure exerted by the foot of the attendant on the treadle. This presses a small pulley against the center of the belt, thus tightening it and causing the disk-plate to revolve, and to carry up the hammer, which is fixed at the end of a connecting rod. The hammer head is made of cast steel and works in a cylindrical guide; it is made hollow and it is fitted with a piston which compresses the air (let into the hammer head) on its upward stroke. On the down stroke the compressed air expands and forces the hammer down with considerable force. The diameter of the air cylinder is 4 in. and the medium stroke 6 in., but this can be varied about 3 in. either way. This hammer has a ram of 50 lb., and will forge iron up to 2½ in. either round or square.

IMPROVED RULING MACHINES.

The manufacture of machines for ruling paper for account books and other purposes has been brought to great perfection by Mr. W. O. Hickok, of the Eagle Works, Harrisburg, Pa. We give an engraving of one of the class known as the O A Pennsylvania Ruling Machine, (new style), with patent striker. It has steam power attachment and ink fountains; can be changed from striker to feint line machine in an instant; will strike any width of paper by changing one gear. Frame, 38 inches wide.



O A PENNSYLVANIA RULING MACHINE.

WASTE CLEANING MACHINE.

We illustrate herewith an excellent machine for more thoroughly separating fibrous material, such as cotton, from dirt, seeds, and other refuse. The waste from pickers, carding machines, and other implements contains more or less cotton, much of which heretofore has been lost for want of a good separator. The machine here shown treats the mixed mass of waste material with great rapidity and success; it separates the staple from foreign substances very perfectly; it is a sort of self-acting mechanism. All that is needed is to start the machine, throw on the mixture, and out comes the cleaned cotton. Made by the Salem Foundry and Machine Shop, Salem, Mass.

SPEED REGULATORS FOR TURBINES AND STEAM MOTORS.

BELL & CO.'S SPEED REGULATOR.

This apparatus is represented in the engraving on next page in front elevation by Figs. 1 and 2, and in horizontal section by Figs. 3 and 4. It consists of an ordinary ball governor, A, whose axle has for support a frame, B, bolted to the wall of the building. This regulator is driven through the intermedium of the bevel wheels, c and c', and of the pulleys, p and p'.

When the velocity of the motor varies in one direction or the other from the normal degree for which the apparatus is designed, the sleeve, a, moves vertically, and transmits its motion by means of the levers, a', a^2, a^3, a^4, to a sort of parallelogram formed as follows:

Two bars, d' and d^2 (Fig. 3), are articulated at one of their extremities, and opposite one another, around fixed axes, b, b', connected with the frame. The other extremities carry forks which correspond to the belt, d^3, which latter passes over two conical drums, D, D', of the same diameter but placed in opposite directions. The bars, d, d', being jointed together by the cross-piece, d^4, it will be seen that a horizontal motion of the latter resulting from a vertical motion of the sleeve, a, will produce a motion, parallel with itself, of the belt, d^3, on the two drums, D and D', and these will revolve at the same speed if the circumference embraced by the belt has the same diameter for both. If, on the contrary, such circumference of contact is greater or less for the drum, D', than for D, the latter will revolve with more or less speed than the other. It is precisely this difference in velocity (which is proportional to the movement of the sleeve, a, and consequently to the variations in the speed of the motor) that is utilized to produce a proportional motion in the gates of the turbine.

The drum, D, is actuated by the shaft, C (Fig. 2), through the intermedium of the pulleys, p^4 and p^5, and of the bevel wheels e, e', e^2, and e^3. The axle upon which the drum, D, is mounted carries a bevel pinion, f, which engages with another pinion, f'. This latter is keyed to a socket which is

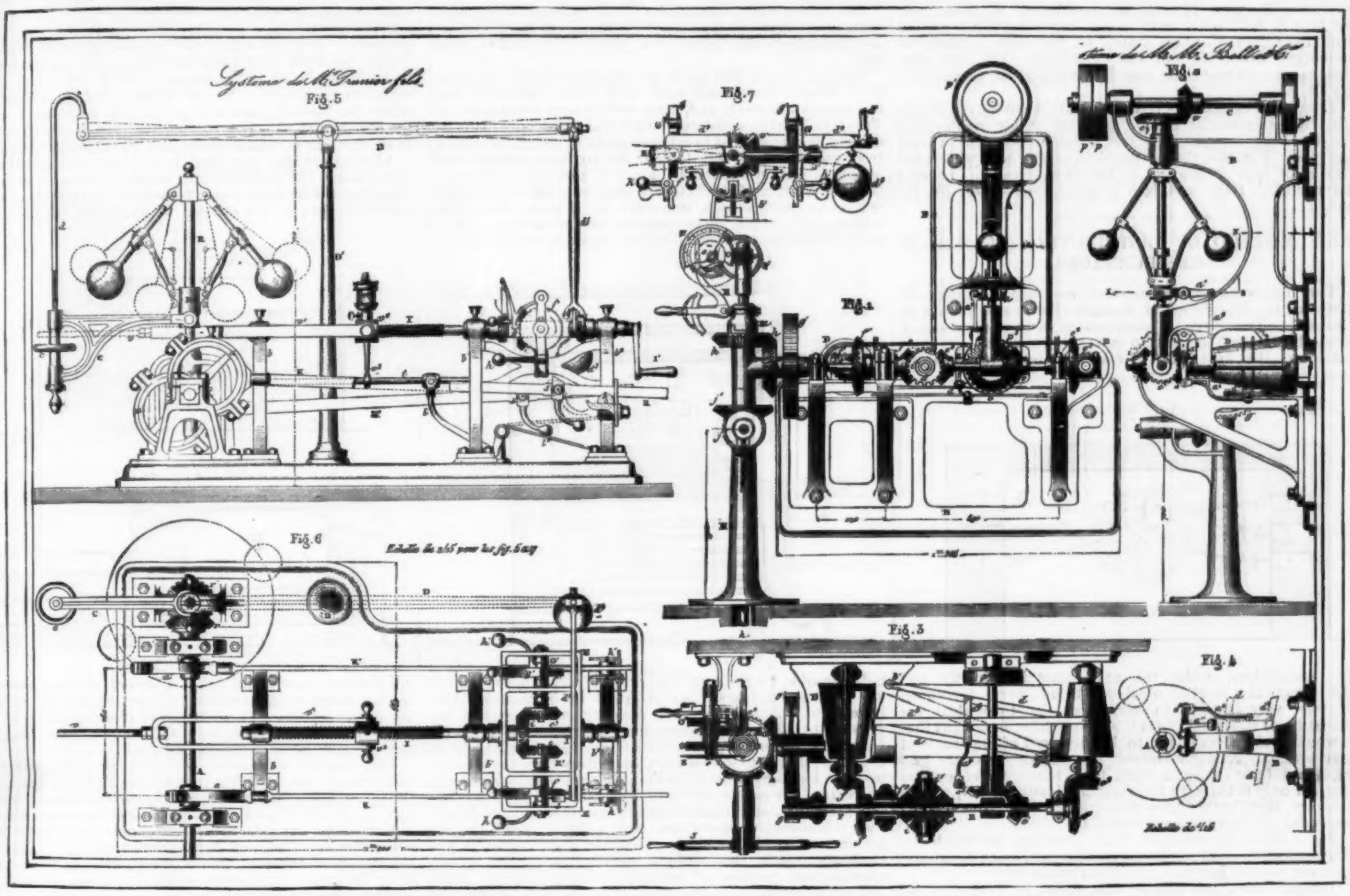
IMPROVED MACHINE FOR CLEANING WASTE.

loose upon the shaft, F, and which is nothing else than a prolongation of the pinion, f^3. A pinion, e^4, similar to the latter, is keyed upon the shaft, E.

At the extremity of the shaft, F, there is keyed a bush, i, which is forged with two journals upon which are mounted loosely the pinions, i' and i^2, identical with f^3 and e^4, and gearing with them.

When the belt, d^3, is placed in the center of the drums, D and D', the velocity of the latter being the same, it will likewise be the same with the pinions, f^3 and f^4, which, in this case, simply cause a revolution of the pinions, i' and i^2, around the journals of the bush, i.

When, on the contrary, the belt departs from its central position, the drums, D and D', will run at a different speed,



SPEED REGULATORS FOR STEAM AND HYDRAULIC MOTORS.

and it will be the same with the pinions, f^3 and e^4, which then will not only cause a revolution of the pinions, i' and i^2, around the journals of i, but will also oblige the latter itself to revolve and carry along the shaft, F, in one direction or the other, according as drum, D, revolves with more or less speed than does drum, D'. The rotation of the shaft, F, moreover, is proportional to the difference between the velocities of the drums, and, consequently, to the variations in the motor's power. The rotation of the shaft, F, is transmitted by the straight gearings, g, g', and the bevel pinion, h, to a like pinion, h', which is mounted loosely upon the vertical shaft, k, of the water gates. Upon this shaft, which is placed in the interior of the column, K, there slides, but does not revolve, a coupling-box, m, which, when at the lower extremity of its travel, engages with the nave of the pinion, h', and it is through the intermedium of this clutch, m, that the said pinion transmits motion to the water-gate shaft. This latter, moreover, may be directly actuated by hand through the intermedium of the pinions, j and j', by acting upon the hand-wheel, J.

As it is always well to know at any moment how wide open the inlet apertures are, the constructor has adopted the following arrangement for showing it: The shaft, K, of the water gate carries at its upper part an endless screw, v, whose motion is transmitted through the intermedium of wheels and pinions, O, o', O', o^2, O^2, to the axis, o, of an index which moves in front of a graduated dial, Z. The wheel, O^2, carries, in addition, a tappet, n, which, when it has reached its limit of travel corresponding to the opening or closing of the gate, abuts against a lever, N, and the movement of the latter effects an automatic ungearing of the clutch-box, m, and the pinion, h'. No danger of breaking is therefore to be feared.

PRUNIER'S REGULATOR FOR STEAM AND HYDRAULIC MOTORS.

The apparatus represented in Figs. 5 to 7 is specially designed for steam motors, and acts either upon the valve that admits steam into the slide-valve box or upon the expansion mechanism. With few additions, and with modifications in size, it may be rendered applicable to hydraulic motors.

The apparatus is represented in front elevation and plan by Figs. 5 and 6. Fig. 7 gives a side view and partial section.

The motor actuates the rod, A, which, through the intermedium of the bevel gearings, r, r', sets in motion the ordinary ball governor, R. The movable socket, R', of this latter carries a sort of bracket, C, which is cast in a piece with two bushes that are freely traversed by a threaded rod which is held by a bronze nut between the two bushes of the bracket, C, and which is cast in a piece with a small hand-wheel, c.

When this latter is revolved in one direction or the other, the rod, d, is caused to rise or descend, and the lever, D, is consequently made to incline to the right or left. From the right extremity of this lever, D, there is suspended a rod, d', which is connected by means of a flat bar, d^2, with a rectangular frame, E. This latter, which is capable of oscillating around the shaft that traverses it, serves as a support to a certain number of parts which are arranged very symmetrically with respect to the axis.

To the bar, d^2, there is hooked a counterpoise, d^3, so that during a normal running the frame, E, shall be horizontal. If the velocity of the motor chances to exceed the normal degree, the balls of the governor or regulator will fly further apart, the socket will rise and carry along the bracket, C, the lever, D, will incline to the right, and the frame, E, will tip at a certain angle. If the velocity of the motor runs below the normal degree, the effect will be just the opposite.

It may be remarked, moreover, that the apparatus may be easily regulated so as to serve for different normal speeds. For this purpose, it will suffice to act upon the nut, c, which latter permits of raising or lowering the rod, d, to a distance just equal to that to which the socket, R', of the regulator has risen or descended, and consequently of diminishing or increasing the speed to the normal degree that served as a basis for the construction of the apparatus.

The tilting motion of the frame, E, effects an advance or recoil of the rod, v, as follows: Each of the smaller sides of the frame, and the parallel cross-piece, E', are freely traversed by a small axle upon which are bolted a toothed pinion, e, and a ratchet-weeel, f, to which latter there corresponds a click, g, whose pivot is connected with a special piece, G, mounted loose upon the axis of the ratchet-wheel. This piece is beveled off below, and carries a counterpoise, h, which, during a normal running, prevents the click from engaging with its ratchet. The same combination of parts is repeated on the other side of the shaft, I.

The pinions, e, and e', both engage with a third one, i, bolted to the shaft, I. The latter, which is threaded along a portion of its length, is connected with the maneuvering rod, v, by a fork, v', and a socket, v^2, playing the role of a nut. It is capable, moreover, of revolving in bearings connected with the standards, b, and b'.

It will now be understood that in order to cause an advance or recoil of the rod, v, and consequently to increase or diminish the opening of the valve of a steam engine or the water-gate of a hydraulic moter, it will suffice to act upon one of the pieces, G or G', in such a way that the corresponding click, in engaging with its ratchet, shall carry along the latter, which in its turn will then cause a revolution of the threaded shaft, I, through the intermedium of the pinion, i, and of one of the two pinions, e, and e'. It now remains to show how the pieces, G and G', are acted upon.

Upon the shaft, A, there are keyed, 180° apart, two eccentrics, a, a', whose collars are mounted at the extremities of two long connecting rods, K K', that rest upon small rollers, k and k', which are movable on supports attached to the standard, b. Each of these rods is traversed by a stud around which freely oscillates a piece, J, or J', which terminates at the upper part in an inclined plane, and, at the lower, in a bent rod that forms a counterpoise.

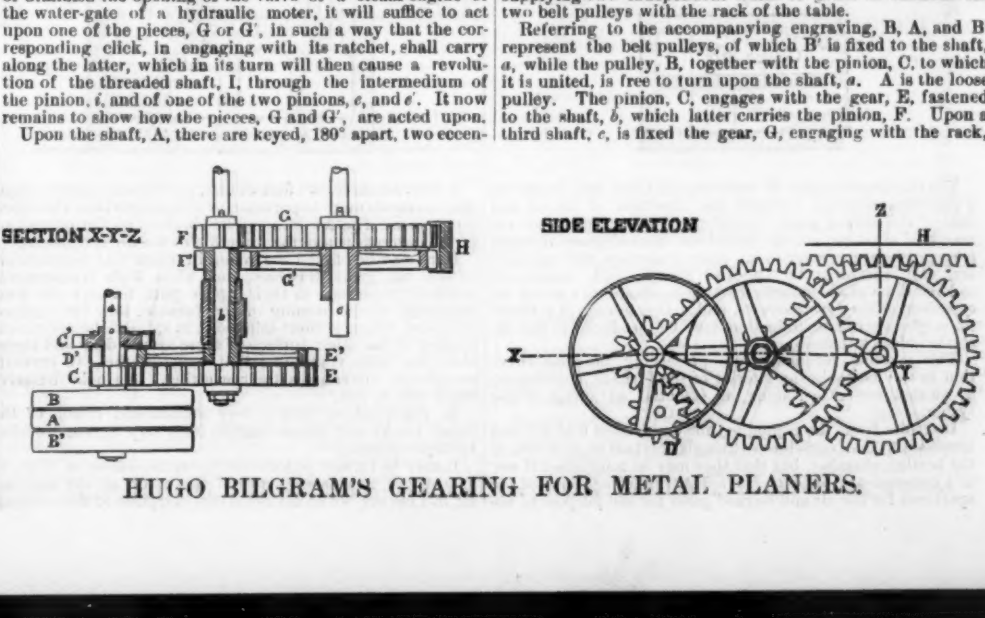
During a normal running, that is to say, when the frame, E, remains horizontal, neither of the two pieces, J and J', meets in its backward and forward motion either of the pieces, G and G', placed on the same side and in the same vertical plane. When, on the contrary, there is an abnormal diminution in the speed, the frame, E, inclines forward and the piece, G, places itself on the line of travel of the piece, J, which, meeting it, causes the click, g, to engage with the ratchet, f. This latter, as well as the pinion, e, is then carried along in the direction shown by the arrow (Fig. 5), and the threaded shaft, I, revolves and effects a recoil. The result is that the water gate, being raised, allows more water to pass, and the speed of the motor increases and reaches its normal degree again. When the speed runs below the normal degree, the opposite effects occur.

To avoid breakage in case the speed of the motor should remain greater than the normal degree for some cause or other foreign to the regulator, the bush, v^2, carries a rod, v^3, which slides along the rod, t, and, abutting against the lever, l', thrusts it back and causes it to lift a bar, l^2, which raises the counterpoise of the piece, J. This latter is thereafter no longer capable of meeting the piece, G, notwithstanding the inclination of the frame, E, and the regulator is, so to speak, thrown out of gear automatically. We may add that the shaft, I, may be actuated by hand, by means of the winch, I'.—*Publication Industrielle.*

HUGO BILGRAM'S GEARING FOR METAL PLANERS.

THE object of the invention is to obviate the jar occasioned by the back lash of the gears at the instant of reversal of the motion of the table, which is accomplished by supplying two independent trains of gears to connect the two belt pulleys with the rack of the table.

Referring to the accompanying engraving, B, A, and B' represent the belt pulleys, of which B' is fixed to the shaft, a, while the pulley, B, together with the pinion, C, to which it is united, is free to turn upon the shaft, a. A is the loose pulley. The pinion, C, engages with the gear, E, fastened to the shaft, b, which latter carries the pinion, F. Upon a third shaft, c, is fixed the gear, G, engaging with the rack,



HUGO BILGRAM'S GEARING FOR METAL PLANERS.

H, of the table. Upon the shaft, *a*, is fastened a small gear wheel, C'; another gear wheel, D', gears both into C' and the gear wheel, E'. By this gear the reverse motion is produced, though both pulleys in their turn are run in the same direction by the belt. The gear, E', is attached to one end of a sleeve, *e*, carrying at its other end the pinion, F'. This sleeve is free to turn upon the shaft, *b*. The pinion, F', engages with a wheel, G', loose on the shaft, *c*, which gears into the rack, H. The machine when thus constructed is run by a single belt that may be shifted from one pulley to the other.

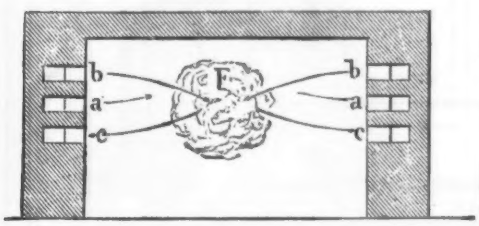
The two pulleys, B and B', are thus connected with the table by two independent trains of gears. When the belt runs on the pulley, B, moving the table by the train, C, E, F, G, H, the second train, C', D', E', F', G', H, will be moved by the rack, H, whereby the teeth of the latter train are kept in working contact, so that when the belt is shifted from the pulley, B, to the pulley, B', the train is ready for immediate action without loss of motion. The same conditions prevail when the belt is again shifted to the pulley, B.

Either one of the two trains of gears when moved in one direction receives its motion from the pulley, while when moved in the opposite direction it derives its motion from the rack. For this reason the teeth of the gear wheels are constantly kept in gearing in the same sense, and hence a jar resulting from back lash is impossible.—*Jour. Fr. Institute.*

NEW METHOD OF DISTRIBUTING FLAMES IN GAS FURNACES.

THE following communication was made January 10, 1883, to the Association of German Engineers, at Aix-la-Chapelle. The mode of distributing flames, of which it treats, being best adapted to cases in which the air alone takes up the heat into special chambers, regenerators,

Fig 1



or recuperators, while the gas comes in directly, and the practical results obtained being very favorable, it was very natural to seek for the theoretical explanation of it, since it might be thought at first sight that it would prove a drawback to be deprived of the agents of regeneration. As a consequence of a calculation of the heat units in different cases, I have been led to the conclusion that not only is there no theoretic disadvantage, but, on the contrary, that there is more than one practical advantage *in employing air only for recovering heat.*

Fig. 1 shows the principle of the invention, for which Mr. Klattenhoff, director of the glassworks at Jumet (Belgium), took out patents last year in various countries.

The gas enters the heating chambers F, from the two sides, *a a*, at the same time, and the air likewise from the two sides, at *b b*, while the burned gases escape at the same two sides, in the vicinity of the entrances, through the apertures, *c c*.

There results from this, in the interior of the heating chamber, currents that take, approximately, the direction shown by the arrows, and the impulsion at the introduction forms an obstacle to an immediate evacuation of the unburned gases from *a* occurring through the neighboring aperture, *c*.

Fig 2.

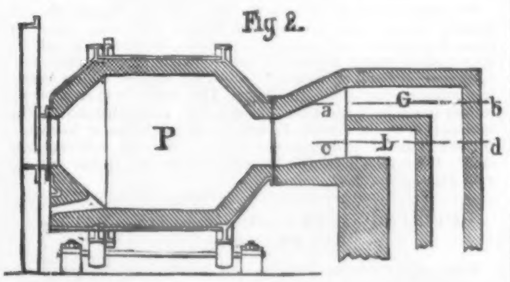
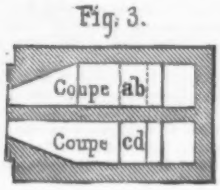


Fig. 3.



For the requirements of regeneration there may be set up a periodical reversal between the direction of the air and that of the burned gases, in such a way as to cause an entrance of air at *c c*, and an exit of the burned gases through *b b*; but it is necessary in all cases to arrange the entrance and exit apertures in opposite groups, and, moreover, to have them close enough together to obtain as a result an *opposition of the flame currents*, and so that in case of a reversal no perceptible modification may be produced in the direction of such flames.

This possible reversal, while preserving the same direction in the flames in the interior of the furnace, constitutes, as we shall see further along, an essential advantage of the system.

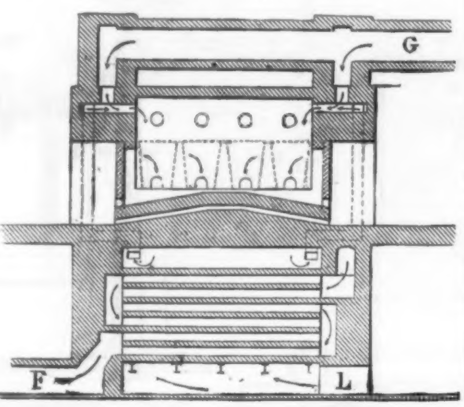
It results from the principle thus enunciated that it is not necessary to limit ourselves to a single aperture on each side of the heating chamber, but that they may be multiplied if we, as a consequence, increase the number or dimensions of the apertures for the air and burned gases for the purpose of obtaining an *opposition of currents* under the conditions indicated.

We may then, likewise, instead of placing the apertures above one another, arrange them horizontally, or at the apices of a triangle, and we may, if there is no reversal, unite the gas and air in a burner before they enter the furnace. If, even, we should suppose a regeneration by the gas with a reversal of the current of gas, we might arrange two apertures, *a*, very near one another. I point out such possibility only as a memorandum, since I remarked at the very beginning that there was no advantage to be looked for in this direction.

Finally, we may admit the case of an application of the opposite currents to a direct heating, which is something likewise of small importance in practice.

The above brief enumeration of the different applications became necessary as regards the principle of the thing, and the examples which follow will give it the desired clearness.

We may, in the first place, propose to ourselves this question: Why do the flames meet each other, instead of each one escaping directly at *c*, after having been formed at *a b*? The fact is that this latter effect does not occur. It is necessary, it is true, that in order to avoid it, the gas in coming from the generator, and the air in becoming heated, shall acquire a certain impulsion; and it is necessary, moreover, that the draught of the chimney shall be regulated in such a way as to balance such impulsion to a point where there will remain a slight mean pressure in the furnace. When such conditions are fulfilled to the degree to which they are

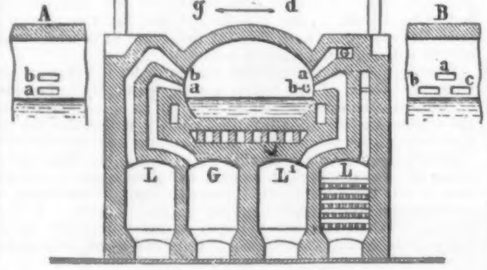


indispensable for the proper working of any other system of gas furnace, the experience required in installations that have been converted into the opposite current system has proved that the two flames may be made to converge from very different points without the escape of unburned products, that is to say, without each flame forming a crook between its point of introduction and the neighboring exit aperture. *Per contra*, the two flames which meet one another acquire, at a slight distance from their point of formation, a tendency to spread out like a fan, to turn about together, and to fill the heating-chamber more regularly and more completely than a flame which, passing in a single direction, consists of unequally heated parallel zones that often subsist throughout the entire distance between the points of introduction and evacuation.

If the gas and air enter the furnace through two distinct apertures, their chemical combination will take place only at a certain distance, and progressively, so that the flame will not be an intense one; and an intimate mixture is none the less guaranteed by a meeting of the currents. Such are the results that have been presented by the furnaces that are already in active operation.

I shall present, in the first place, as examples of the application of opposite currents, two arrangements of Martin-Siemens furnaces, one with reversed current air regenerators (Figs. 10, 11, and 12), and the other with constant current air recuperators (Figs. 13 and 14). These two latter figures show how the gases come from the generators at G, and are distributed toward the conduits, *a a*, in uniting at *b b* with the air, which, having been introduced at L, beneath the furnace, has passed horizontally into the recuperators and become heated therein; while the burned products escape at *c c*, traverse the recuperators vertically, and heat them before disappearing at K into the chimney.

Fig 5



I describe these two figures first, not because their arrangement presents more importance or advantages than the other, but because a better idea can be obtained of the opposition of the currents where the direction of the air is constant.

Here may be offered the general remark that recuperators possess the great drawback that when high temperatures suddenly supervene at their upper part through the least negligence in the running of the furnace, they are exposed to a local fusion of their thin sides, in spite of the permanent cooling of the other surface of these same sides; and thereafter the least communication between the two currents completely disarranges their working. A single defective brick will do this.

In regenerators, even a very pronounced fusion of the upper bricks still leaves margin for a very regular working for some months.

It may be further objected to the arrangement of Figs. 13 and 14 that, as a consequence of the union of the gas and air in a burner, we do not avoid that sharpness of flame which is so dangerous in glass furnaces, and which in the Martin-Siemens furnaces increases the well known inconvenience of the wear of the inclined dome in the vicinity of the flame's introduction.

But the burner does not form an integral part of the arrangement; it serves here only as an example, and may just as well be replaced by distinct apertures for the air and gas, as in the installation represented by Figs. 10, 11, and 12, and in which the reversal of the current of air requires the introductions to be separate. This latter installation is the most original and also the most important, because it allows us to see at the same time how we may adopt the system of opposite currents to a Siemens furnace provided with two gas and two air regenerators. Here the four regenerating chambers have been transformed by simply taking down two small separating walls into two double air regenerators, R and R', in which the air enters alternately at L into the regenerator, R R, to enter the furnace at *b b b*, while the burned products make their exit through *c c c* of the furnace, and through L' of the regenerator, R' R'; or, after the reversal of the damper, the air enters through L' and *c c c*, while the burned gases escape through *b b b* and L toward the chimney at K. The combustible gas comes in continuously through G, and is distributed in the furnace at *a a*.

Although in this case there is no longer any question of a sharp flame, one inconvenience much less dangerous is to be feared, and that is, in a short furnace, an excessive concentration of heat in the center. If we do not wish to or can-

Fig. 6.

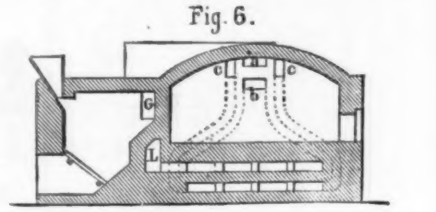
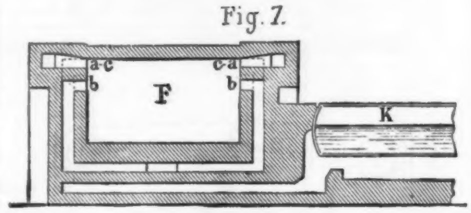


Fig. 7.



not have recourse to the use of a burner, we may succeed in having a perfect equalization through supplementary jets of gas in the corners. These details of construction must form in each particular case the object of a special study, and have already found their application in practice.

This subject must not be left without noting that everywhere where the letter *o* is found it designates a sweep hole, the use of a gas that is not much heated rendering it necessary to get rid of soot. Before passing to a description of different other applications, it may prove of interest to examine whether this new arrangement has any ancestors in the history of furnaces, that is to say, whether there are no other anterior systems with which it can be compared. As regards this, I have met but two cases that deserve to be noted:

1. The Siemens rotary furnace for the preparation of fagots for puddled steel or for the direct production of cast steel (Figs. 2 and 3.) The part, P, revolves around its horizontal axle by the aid of a mechanism of which Fig. 2 gives a partial view. For distributing the flame, the gas enters at G, and the air at I (Fig. 2), alternately to the left and right of a dividing wall (which is figured on the horizontal section, Fig. 3), while the burned gases make their exit alternately to the left and right of the wall in the immediate vicinity of the inlet. Although the part, P, is about three meters in length, the flame reaches the other extremity without any

Fig. 8.

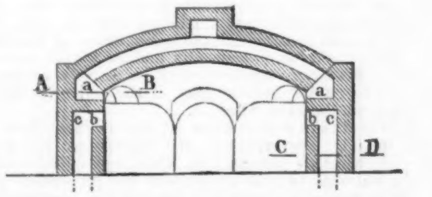
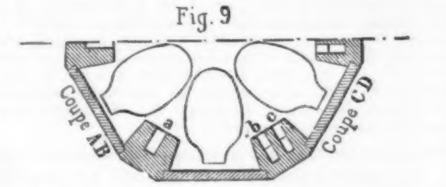


Fig. 9



trouble. It describes in its travel, however, a curve that does not exclude the parallelism of veins that are unequally hot. There is no *opposition*, but a *return* of the current, and regularity in the distribution of heat is obtained only by revolving the furnace. But with this apparatus an intense heat has been produced, and the fact that the introduction and evacuation, although operated side by side, do not come into collision, and that a length of three meters appears to be advantageous to this process of returning the flame, proves that in the process of opposite currents a length of six meters is favorable.

2. Fig. 4 represents the Radot and Lencauchez furnace, into which the gas enters through a pipe, G, over the furnace, and is distributed toward the two heads of the heating chamber, and there meets, in two burners, the air that has entered at L and has become heated by rising in the recuperator before becoming distributed in the two burners. The products of combustion escape vertically through the base of the furnace pillars, and from thence into the recu

perator, which latter they traverse horizontally and heat before escaping through F into the chimney. This kind of distribution of flames does not exclude the parallelism of the zones of heat that surround the pots. The opposition of the currents stops at its début, and this arrangement is essentially, as compared with our system, a still-born child. Besides, it does not permit of a reversal of the air current, and is consequently applicable to the recuperative system only.

We know, nevertheless, that this arrangement does not give bad results; yet the position of the gas conduit over the furnace is to be deprecated, since there results therefrom a cooling, instead of the combustible gas tending to heat itself in contact with those parts of the furnace that require to be cooled.

The following figures show the application of opposite currents in different cases of practice. They are but simple theoretic sketches, designed rather to indicate the possibility than the best means of making such application:

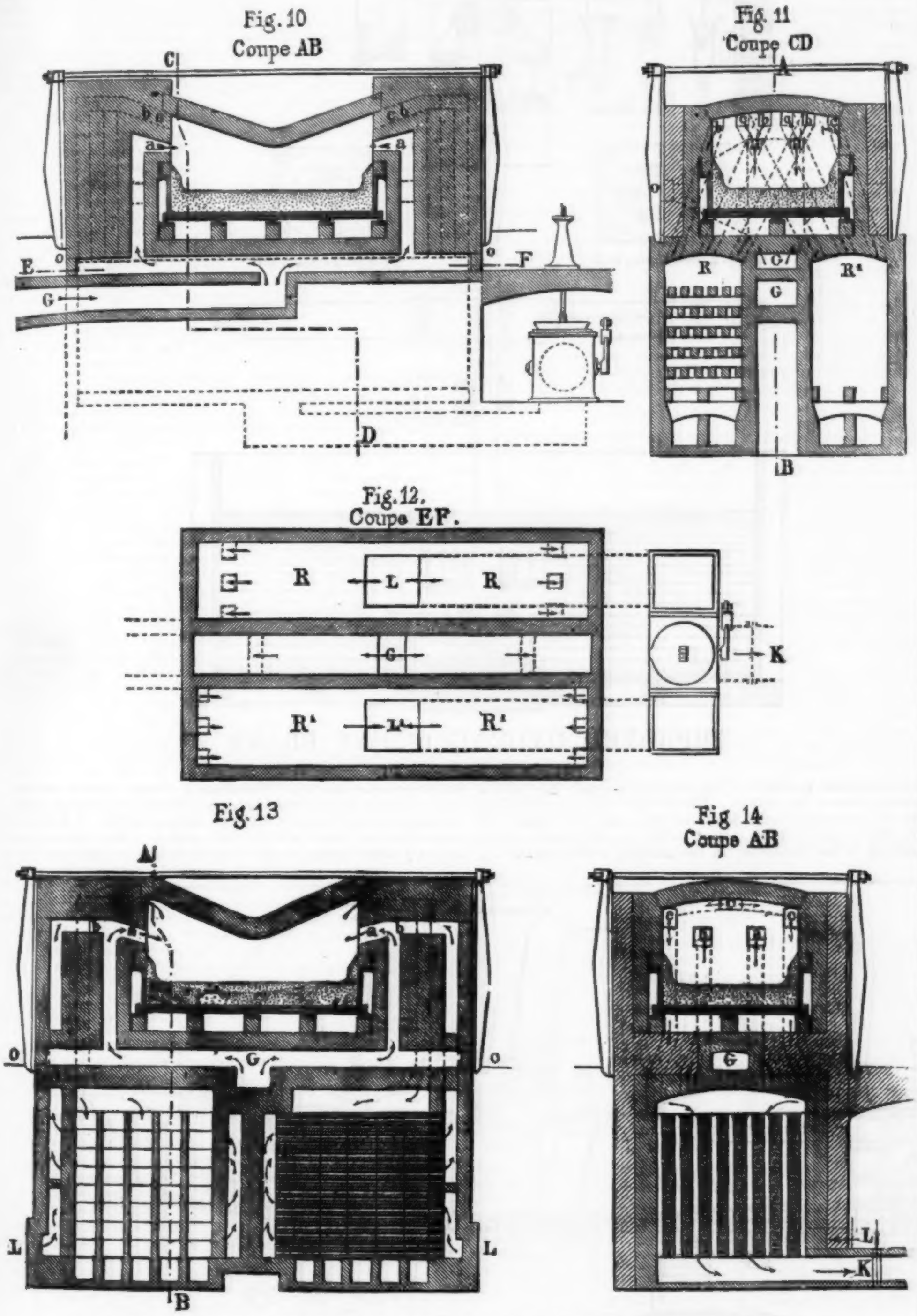
I take for granted Siemens crucible furnace for the continuous working of glass to be known. If we imagine the left part, *g*, of Fig. 5 carried out symmetrically to the right, the whole will represent a cross-section perpendicular to the large axis of the furnace such as it is now known. The gas comes from the regenerator, G, through *a* into the furnace, and the air from the regenerator, L, through *b*; and the burned gases escape from the other side through *a b*, and inversely, after the reversal of the dampers. Each side along the furnace presents several apertures, *a*, and as many apertures, *b*, and the projection, A, is reproduced several times. If the straight side, *d*, of the figure be drawn symmetrically to the left, the whole will represent the modification according to the system of opposite currents. The gas enters at once from the two sides at *a*; and it is likewise from the two sides at once that the air and products of combustion alternate, the one entering at *b* or at *c*, while the others make their exit through *c* or *b*, and the projection, B, is reproduced as many times as, in the other case, projection, A, is.

The chambers which formerly constituted the gas generators, G, have become air regenerators, L'. If, as often happens, they are smaller than the others, they will nevertheless offer sufficient surface to heat the air alone; otherwise it would be necessary, by modifying the branching of the channels, to cause the regenerator, L, to the right, to act with L' to the left, and inversely, for the entrance. Care must be taken that the gas does not become cool in the collecting channel, G, and also that it shall become heated, if possible, under the sole of the furnace. In the figure, the gas enters above the air. This arrangement is adopted rather to make the sketch clearer than for any other purpose. This relative position of the apertures has no importance as regards the intimate mixture of the gases, since the opposition of the currents completes it; but it is more favorable than prejudicial, since, when the gas is not so hot as the air, it remains heavier than it. This also has the advantage that it prevents veins of gases that are not yet completely inflamed from coming in direct contact with the surface of the melted glass.

The crucible furnace may be designed for intermittent work, either whether we work the glass between two fusions, or whether we allow to flow at one time the whole contents of the furnace under the form of cullets, processes which, for several reasons, have not yet entered into the domain of practice. As, in installations of this kind, the glass is worked from the sides, and the heating is done at the ends, we may imagine the drawing modified in such a way that the figure shall represent a lengthwise section of the furnace, and that the two groups of regenerators shall be a little more distant from one another, the flames, however, being distributed according to the same principle, but at the top instead of at the sides.

In the two kinds of crucible furnaces, the effect of the opposite currents permits of counting upon a better distribution of heat, and upon the concentration of it in the center of the glass, and, consequently, likewise upon not so rapid a determination on the skimming line of the glass.

We have, up to the present time, supposed regenerators or recuperators to be used for the heating of air. To answer an objection of a forge master who pretended not to be able to adopt the opposition of currents because he employed the waste heat from his boilers, I have added Figs. 6 and 7. It is clear, however, that a mode of distribution of flames and the utilization of waste heat are two distinct things. So it is only to confirm the preceding *exposé* that I vary the examples. The heating chamber, F, may represent that of a superheating, roasting, puddling, or other furnace. The generator is against the furnace. The air enters at L, becomes heated between the generator and the furnace wall, then under the furnace, between the sole and draught-channel, and reaches at *b b* the two furnace heads. The gas is distributed from G to *a a*, and the products of combustion issue through *c c*, and from thence escape under the boiler, K, into the chimney.



DISTRIBUTION OF FLAMES IN GAS FURNACES (KLATTENHOFF'S SYSTEM).

Up to the present, we have presented square furnaces only. Figs. 8 and 9 represent a round, six covered-crucible glass furnace. The gas comes in above the dome, becomes heated in contact with it, and enters the furnace at *a*, through the six pillars at once. The air enters at *b*, and the products of combustion make their exit at *c*, or inversely and alternately. The opposition of the currents takes place between two opposite pillars, and the different currents mingle very intimately in the entire space. If the furnace has a larger number of working holes, and two pots, for example, in each one of them; there will remain in the center a great empty space, which we may suppose occupied by a central pillar in which there may be formed apertures for producing oppositions of currents between the central pillar and the external ones.

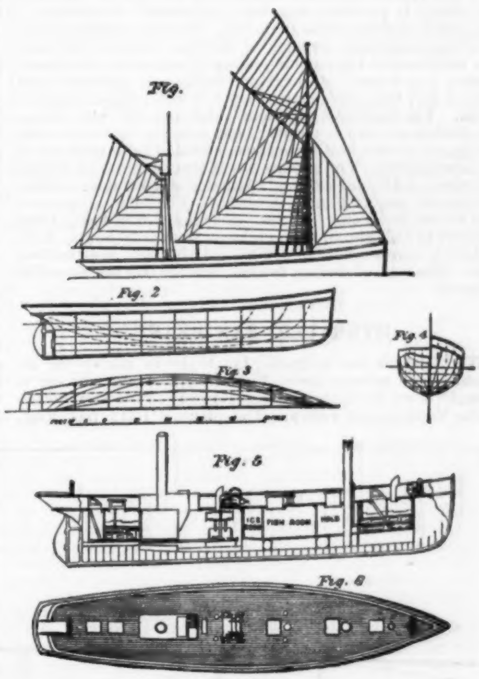
Examples *ad infinitum* might be presented of applications of the principle to zinc, lead, porcelain, and other furnaces; and we may imagine to ourselves furnaces in the form of a vertical crucible with superposed series of opposite currents. We might, even, by taking special precautions, set up an opposition of currents between the sole and dome of certain furnaces. But all this would have to be the subject of a special study for each particular case.

In conclusion, I may again cite the advantages that the inventor has found on transforming into this system several Siemens furnaces:

1. A 15 per cent. saving in fuel, or, better stated, a reduction of 15 per cent. in the duration of operations for the same consumption in a unit of time—a result which in every kind of industry is of more value than a diminution of expense in the same time and for the same production.
2. Costs of installation less by one-third than those of the Siemens arrangements.
3. Facility in the cleaning of the channels, and freedom from explosions.
4. A longer duration of the bricks in the regenerators.
5. The great facility with which the present Siemens furnace may be changed to the system under consideration.
6. Great regularity in the heating.—*A. De Boischevalier, in Le Génie Civil.*

STEAM TRAWLERS.

We publish drawings after which a small fleet of steam trawlers are being built to the designs of W. E. Redway,



STEAM TRAWLER.

engineer, of Milford Haven, the first half dozen vessels being at the present time well on toward completion.

The following are the leading particulars of the vessels:

	ft.	in.
Length by Lloyd's measurement	87	6
Breadth " "	20	0
Depth " "	12	4
Depth of hold	10	8
Load draught	10	6
Least height of freeboard	2	9

Tonnage.

	Tons
Gross register (approximately)	96
Net " "	50
Builder's measurement	155
Weight of hull	62
" machinery	20
" outfit	15
" coal	20
" water	10
Total dead weight capacity	48
Total displacement	175

Elements of Design of Hull.

Length of fore body	48 ft.
" after "	40·5 ft
Area of immersed midship section	118 sq. ft
Ratio that area of immersed midship section bears to its circumscribing rectangle	0·65
Area of load water plane	1218 sq. ft
Ratio that area of load water plane bears to its circumscribing rectangle	0·688
Displacement per inch of immersion at load water line	2·9 tons.

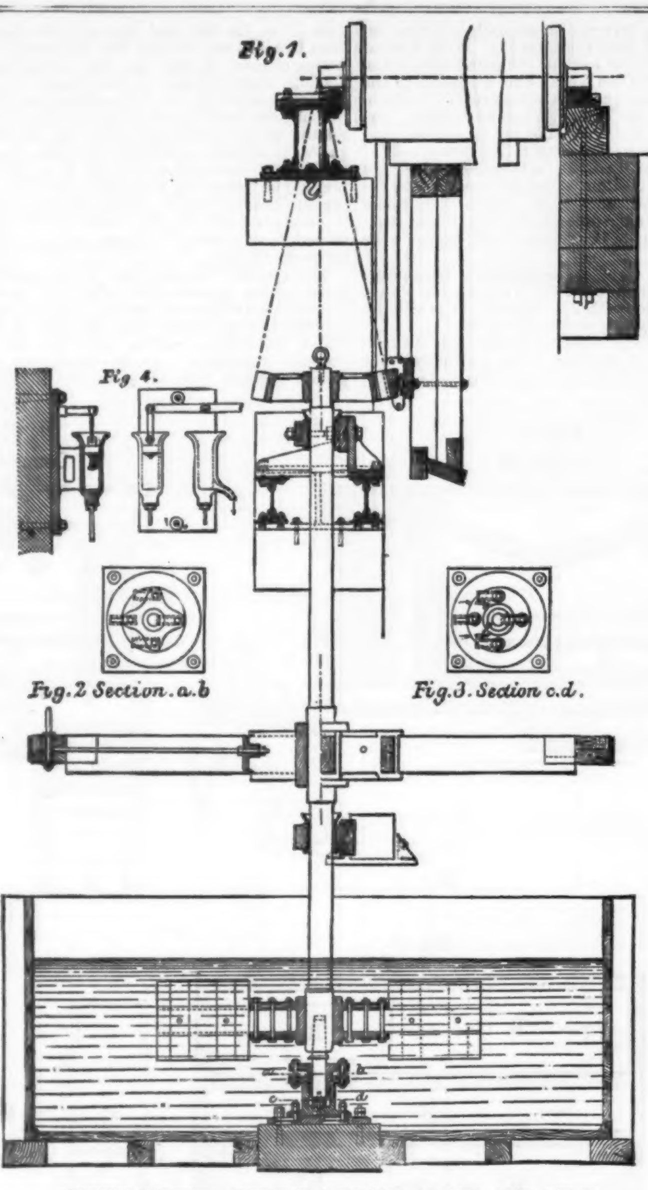
Square feet of immersed surface......	2082
" " augmented "	3836
Coefficient of fineness = $\frac{\text{displacement}}{L \times B \times D}$ =	0·390
Area immersed vertical longitudinal section	770 sq. ft.
Center of lateral resistance from fore end of L. W. L........	47·4 ft.
Center of buoyancy below L. W. L .	2·99 ft.
Metacenter above center of buoyancy,	4·68 ft.
Area of lower sails	2238 sq. ft.
Center of effort above L. W. L	29·25 ft.
" " abaft fore end of L. W. L............................ ..	46·25 ft.

The engines fitted to these vessels are of the ordinary inverted compound surface condensing type with an intermediate receiver. The cylinders are 12 in. and 24 in. in diameter, the stroke being 24 in. They are to be supplied with steam by an ordinary return tube steel boiler.

The vessels are classed 90 A at Lloyd's, and as shown in the illustration are dandy rigged. There is, however, no mizzen-mast proper, the funnel serving for hoisting the after sail upon a plan which has evoked most hearty expressions of contempt from some old fashioned fishermen, but which, nevertheless, has stood the test of practical experience and been found to answer well. There is no bowsprit. It is anticipated that the engines will give out about 120 indicated horse power, and with the fine water lines and beautiful models Mr. Redway has given these craft, a good speed should be attained.—*Engineering.*

TWIN SCREW TUG BOAT FOR THE RHINE.

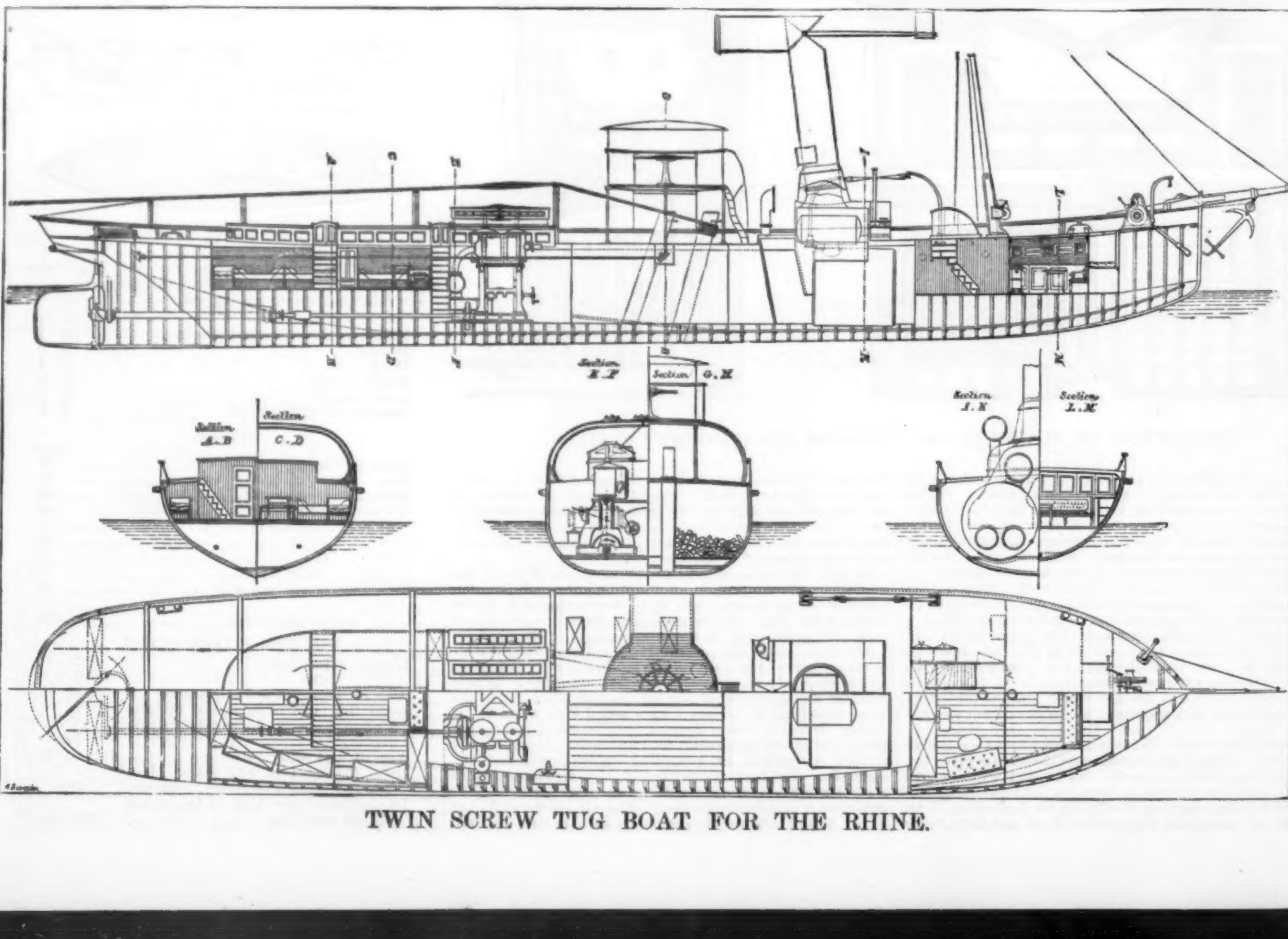
The twin screw tug boat which we illustrate herewith has been recently built by Messrs. Sachsenberg Brothers, of Rosslau, for Messrs. Mellinghoff Brothers, of Mullheim-on the-Ruhr, and is intended to ply on the Rhine. The dimensions are: Length, 38·5 m.; breadth, 7·2 m.; and depth, 3·2 m. The keel plates are from 7 to 9 mm. thick; stem, 130 by 25 mm.; stern, 120 by 55 mm.; frames, 50 by 80 by 8 mm., 60 by 80 by 8 mm., and 52 by 65 by 8 mm.; the distance from center to center being 550 mm. in the fore part, with intermediate frames. The keelson is of double angle iron 70 by 90 by 8 mm., the side keelsons in the bilge being of double angle iron 50 by 80 by 8 mm. The deck beams, which measure 80 by 130 by 10 mm., stand at a distance of 1,100 mm., and are connected to the frames by strong iron knees. The transverse framing of the hatchways is of plate and angle iron, and they are firmly connected together by fore and aft carlings The vessel is provided with four water-tight bulkheads, 5 mm. thick, stiffened with angle iron. Two coal bunkers, with coal boxes, on deck, capable of holding together 60 tons. The thickness of the outside plating is as follows: Garboard strakes, 7 to 9 mm.: strakes, intermediate, to garboard and bilge, 6 to 7 mm.; bilge strakes, 6 to 8 mm.; upper strakes, 6 mm. The bulwarks are 3 mm. thick and 600 mm. high. The boilers are two in number, and contain together about 190 square meters heating surface, certified for a pressure of 6½ atmospheres. The engines are independent, with double cylinders of 420 and 700 mm. diameter and 630 mm. stroke. The screws are 2,100 mm. diameter. The boat is guaranteed to tow three iron barges, carrying 1,600 tons, from Ruhrort to Cologne in from eighteen to twenty hours, with an hourly consumption of 500 kilogs. of good Westphalian coal. The cost, including fittings, was 128,000 marks.—*The Engineer.*



IMPROVED HYDRAULIC FAN BRAKE.

HYDRAULIC FAN BRAKE.

We illustrate the hydraulic fan brake in use on the inclined plane railway above Vordernberg, where the ore is brought down from the Eisenez Railway to the storehouses in the Vordernberg Valley. The plane is 1,312 feet long, with a uniform gradient of one in four—a single line with a passing place at the center. The descending and ascending loads are respectively 9·75 and 5·5 tons, and are worked by wire rope from a double coned driver (partly shown in the figure) of 19 feet diameter in the middle, which makes 7½ revolutions per minute. The drum is geared directly with a vertical brake shaft whose lower end works in an adjustable footstep bearing, fitted with a gland for facility of lubrication. On this shaft are the two brakes. The upper is an ordinary drum brake, about 12 feet 3 inches in diameter, ap-



TWIN SCREW TUG BOAT FOR THE RHINE.

plied by hand in the ordinary way. The lower brake is the hydraulic fan. It has four arms about 7 feet in diameter over all, each fitted with a wooden blade about 20 inches by 24 inches. The area of the blades, as well as their radius, and the depth of water above them, can be varied as may be required, so as to suit various speeds and resistances. The fan works in a tank about 12 feet square. We are informed that the system acts well, proves itself adaptable to varying loads, and gives little trouble under the ordinary conditions of practical work.—*Engineering.*

ROBERT GRIFFITHS.

WE regret to announce the death, on June 16, at his residence in Ledbury road, Bayswater, of Mr. Robert Griffiths, "the father of screw propellers," as Captain Bedford Pim once called him. Mr. Griffiths was the son of a farmer near Bodfari, a parish in the vale of Clwydd, North Wales, where he was born December 13, 1805. At a very early age he began to display a decided mechanical turn, and he was taught the trade of a carpenter. After working for some time at Rhyll, he removed to Birmingham, where he found employment as a pattern maker, but in a short time he was enabled to start in business for himself as a machine maker. In 1835 he took out a patent for a machine for making rivets, screw blanks, and bolts, and in the following year he patented, in conjunction with John Gold, a very ingenious machine for grinding glass. In 1836 he appeared as the patentee of a nut-making machine, and in 1845 he patented another machine for making bolts, spikes, and rivets. The bolt and nut machines were highly successful, though the inventor him self, as often happens, failed to reap any very substantial benefits. It is stated that a Mr. Alcock, who took the rivet works when Mr. Griffiths left, made no less than £60,000 in a very few years, and we believe that we are correct in stating that Mr Griffiths' inventions laid the foundation of the important nut and bolt industry of the town. From Birmingham he migrated in 1845 to Havre, where he started an engineering workshop and iron foundry in conjunction with a Mr. La Bruyere. The concern prospered for a time, and some work was executed for a railway then in progress in the neighborhood. Political troubles caused the business to fall off, and eventually the works were closed. While at Havre his attention became directed to atmospheric railways, from which great results were expected at that period, and he took out two patents in 1845 and 1846 respectively, relating to the subject. He was associated in these ventures with the late Mr. George Hinton Bovill, whose name is well known in connection with improvements in corn grinding machinery. We have now arrived at the time when Mr Griffiths commenced to investigate the subject with which his name is indissolubly connected, the improvement of the screw propeller, his first patent being dated September 13, 1849. We understand that some of his early experiments were directed to the determination of the loss of power which would ensue by increasing the size of the boss for the purpose of giving additional strength. To his surprise he found that no such loss as he had anticipated took place, and this led him to a discovery which was totally opposed to all the then received notions. The experiments were made in conjunction with Mr. Bovill, who, in July, 1852, read a paper on the subject before the Institution of Mechanical Engineers in Birmingham. Instead of continuing the blades of the propeller down to the shaft, and keeping the boss as small as possible, one-third of the diameter was filled up by a sphere. In the experiments which Mr. Griffiths and Mr. Bovill made it was ascertained that the center part of the blade of the ordinary screws absorbed 20 per cent. of the power, without having any propelling effect, in consequence of that part of the blades—especially in coarse pitched screws—being nearly in a line with the shaft, the effect being when working to hurl the water off by its flapping and centrifugal action at right angles to the shaft, and seriously disturbing the more solid water upon which the more effective portion of the screw should act. Further improvements in the screw were embodied in two patents granted in 1853.

Shortly after this patent was taken out, Mr. Griffiths left Havre and settled at Bristol, where the first trials were made with the improved propeller. It was also tried in London and at Liverpool. In March, 1853, experiments were made by the Admiralty at Portsmouth with the royal yacht Fairy, to which one of the new screws was fitted. In June of the same year the Peninsula and Oriental Company took the invention up, and made experiments with it on the Cadiz. The details of these experiments will be found in the *Mechanics' Magazine* of the day. As an instance of Mr. Griffiths' ceaseless inventive activity we may mention that while at Bristol he found time to devise and patent an electric hair brush and comb. About this time he was employed by Messrs. Swayne and Bovill, at Briton Ferry, to superintend the rolling of a particular kind of wrought iron chair or sleeper for a foreign railway in which they were interested. In 1853 he came to London, and for ten years or so he resided in Mornington crescent, closely occupied with introducing and improving his screw propeller. His next move was to Chester, and thence, shortly afterward, to Rhual Issa, near Mold, where he became the principal proprietor of a colliery and commenced the manufacture of paraffine oil from shale. This enterprise was not successful, being ruined by the large importations of crude petroleum from America, and Mr. Griffiths retired from the concern a considerable loser. He returned to London again and concentrated his energies on the screw propeller, his numerous improvements being only recorded in the patent lists. During the later years of his life he turned his attention to methods of protecting screws; and his "protector" was tried on the Bruiser at Plymouth, in 1875, with very satisfactory results. It formed the subject of a Parliamentary paper in the following year. It consists of two concentric rings firmly attached, the larger one being in advance of the smaller. They are fastened at the top and bottom to the screw frame so that the forward edge of the smaller ring is opposite the middle of the propellers Experiments have shown that the efficiency of a screw propeller is increased by this "protector."

Mr. Griffiths has contributed several papers to various societies, the last of which was perhaps that read at a meeting of the Royal United Service Institution in April, 1881, on "Recent Experiments in Screw Propulsion." In that paper he enlarges upon the importance of placing the propeller a considerable distance aft of the stern post. He also wrote a pamphlet in 1860, entitled "The Screw Propeller; what it is and what it ought to be," and "A Description of Griffiths' Improved Patent Screw Propeller, with its Recent Improvements under Patent No. 319, February 20, 1858."

Such is an imperfect and somewhat superficial sketch of the career of a very remarkable man, whose inventions have exercised an important influence upon the subjects to which they relate. It is to be hoped that a fuller record of his work may be compiled by those who have been more closely associated with him. Mr. Griffiths leaves a widow and a son, the latter of whom has been for some time connected with his father in engineering pursuits.—*The Engineer.*

[Translated for the SCIENTIFIC AMERICAN.]

ASPHALT—ITS ORIGIN, PREPARATION, AND USES.

THE following interesting article is taken from the *Praktische Maschinen Konstrukteur:*

Asphalt is a peculiar substance, the origin and nature of which, in general, is but little understood. Although its preparation on a large scale dates back scarcely three decades, it forms the basis of one of the most flourishing industries, and has become almost indispensable for public structures and for beautifying cities.

ORIGIN OF BITUMEN.

It is one of the most frequently occurring forms of a mineral known under the general name of bitumen, as well as its most solid form. As to the origin and formation of bitumen, the views of geologists differ greatly. While some consider bitumen to be an empyreumatic oil formed by a process of decomposition to which the vegetation of the primitive forests whose remains are still found in vast quantities have been subjected in some prehistoric age, others are of the opinion that this substance in its original liquid form (as rock oil) was a product of the dry distillation of stone coal or brown coal, the distillation having been effected either by the agency of volcanic fires or subterranean fire, or heat generated by the decomposition of pyrites.

PURE ASPHALT.

Under the name of pure asphalt (and in German Erdharz, Erdpech, and Bergpech) is understood an opaque mass of almost coal black color with a smooth, glossy surface and concoidal fracture, with an empyreumatic (or burnt) odor, which is perfectly insoluble in water, melts at the temperature of boiling water, and is found native in nature in regular deposits, but more frequently mixed with a soft kind of rock, the pores of which are filled with it. Since the union of the bituminous substance with that particular rock is a purely mechanical one, and not in any definite proportions, variations are frequent, not only in different places but even in one and the same deposit, and in most cases the deeper layers are richer in bitumen than the upper ones.

TRINIDAD BITUMEN.

The most remarkable occurrence of an almost pure asphalt is that near the mouth of the Orinoco in the island of Trinidad in the West Indies. On the highest point of the island, surrounded by a luxuriant vegetation, but situated in a circular depression, is a sea of asphalt called Pitch Lake, about 1·8 kilometers (one mile) in diameter. Its bituminous odor is perceptible for leagues around. From a distance it might be taken for water, but viewed nearer it has more the appearance of glass. Around the border of the lake the pitch is quite hard, while toward the middle it forms a soft mass which is quite warm. Frequently wide cracks appear in this mass, and subsequently they close again; hence it is supposed that there must be water beneath.

DEAD SEA.

Asphalt is found in considerable quantity in the Dead Sea, that large inland sea of Syria, whose barren shores and surface devoid of vegetable and animal life completely justify this appellation, where it bubbles up in a liquid state from many springs at the bottom of the sea, but gradually solidifying from contact with the water it collects in clumps that collect on the surface of the water, which is specifically heavier from its excessive saltness.

IN CUBA AND WEST INDIES.

Asphalt is abundant in Cuba, Barbados, and some other islands of the West Indies. It is collected in the neighborhood of Havana, and comes into commerce under the name of chapopoda or Mexican asphalt.

EUROPEAN ASPHALT.

No real asphalt in the pure state is found in Europe; there are some isolated deposits of a substance resembling asphalt, but generally soft and easily fusible, or argillaceous, schistose, and calcareous rock or sandstone saturated with asphalt (asphalt rock). In France this rock is found at Aniches, in the Departement du Nord; at Seyssel, in Departement Aix; at Bastennes, in Departement du Landes; at Lobsan, in Departement Bas-Rhin; also at Bechelbronn, in Alsace; at Val-de-Travers (Swiss Canton of Neuenburg); on the Island Brazza, opposite the city of Spalato; in Dalmatia; at Hagenau, in Westphalia; at Limmer and Wietze, in Hanover, as well as at different places in Braunschweig.

IN ENGLAND.

The occurrence of asphalt there is very limited, it being found only in small quantities in a few coal mines and peat beds.

SOFT ASPHALT.

The softer kinds of asphalt, called mountain tar (Bergtheer), mostly forms a dark brown, thick fluid, very similar to coal tar, but easily distinguishable from it by the bituminous odor, which is evidently due to the partial conversion of rock oil into resin. In the places where it occurs the asphalt either collects on the water of wells dug for the purpose, or is obtained from the rock in which it occurs.

SEPARATING IT FROM THE ROCK.

The asphalt is separated from its accompanying rock in one of two ways. The best method is that in use at Bechelbronn and Seyssel, where the broken rock is boiled with water or a dilute solution of potash, which melts the asphalt, and it collects on the surface, while the other constituents sink to the bottom. The asphalt thus obtained is still further purified by fusing it again.

In other sections, for instance in Venice, where the Brazza asphalt rock is mixed with pure asphalt to make a cement or "mastic," a sweating process is in use, the rock being heated in a specially constructed furnace and the asphalt collected as it flows out.

ASPHALT ROCK.

The mineral substance now called "asphalt," which has attained such an industrial and commercial importance owing to its use in paving streets and sidewalks, is a porous limestone more or less strongly impregnated with a bituminous substance, or is a lime sand cemented together by the bitumen in it. Under the microscope the latter looks like a fine grained conglomerate, each little granule being enveloped in the resinous substance which cements it to its neighbor.

When this asphalt rock is heated to 176° or 212° F., the bitumen melts, destroying the bond that holds the particles together, and converting the mass into a dusty powder. If this powder is subjected to a heavy pressure while hot, or after being reheated, the particles unite again, so that when the mass is perfectly cold its previous consistence is restored (the use of asphalt for making streets depends upon this peculiarity).

ORIGIN OF ROCK ASPHALT.

The opinions of naturalists differ essentially in regard to the cause of this and the manner in which the rock was first formed. One party claims that it was produced by the precipitation of particles of lime in a lake of asphalt, but new experiments made on asphaltic rocks have led to the hypothesis that at some previous epoch, which cannot be determined with certainty, large quantities of organic matter were buried under the lime rock, and the products of decomposition being converted into vapor by the internal heat of the earth, and seeking an exit, made a rent in the crust of the earth and forced its way upward with a power proportional to the pressure that it was then under, passing by the denser strata until it reached the oolitic formation of the Jura lime, the pores of which it penetrated.

MINING ASPHALT.

Asphalt rock is generally mined by galleries and tunnels blasted out, but the borings can generally be done by hand. As the firmness and hardness of the asphalt increases and decreases in the same proportion as the temperature rises and falls, it is quite hard down in the mines where the temperature is low compared with that in coal mines, but after the mineral has been brought to the surface its hardness varies with the season, so that it is hard and brittle in winter, soft and tenacious in summer, and if exposed to the sun for a few days it crumbles to dust.

HISTORICAL.

As already indicated, it was the observation of this property that first suggested the use of "compressed asphalt" for roadways. Here, too, as so often happens in the history of a discovery, it was an accident that turned industrial progress in a new direction. At the time when the asphalt beds of Val de Travers began to be worked, it frequently happened that in transporting the mineral from the mine to the place where it was to be used, pieces fell off the wagons and were ground up and pressed by the wheels until finally they formed a kind of asphalted turnpike. From this circumstance the Swiss engineer Mérian conceived the idea of asphalting a portion of the road that led through one of the Jura defiles from Val de Travers to Pontarlier, in the French Department of Doubs, a road which received much traffic. Of course, this being the first attempt, it was not very skillfully performed, nevertheless the process had been discovered and the problem of the future was to make it useful on a continually increasing scale.

The first time that compressed asphalt was used for making a road-bed was in 1849. In the following year the French engineer Darcy, Inspector General of Streets, in his report to the minister of Public Works, spoke of asphalt as *the* material of the future for street making, and at the same time he proposed to use it for a part of the boulevards of Paris. It was not until 1854 that the first experiment of this kind was made in Paris. Since that time the use of compressed asphalt has extended rapidly.

COMPRESSED ASPHALT.

The method of applying this is essentially as follows: The road-bed must first be prepared of the proper shape and well rolled; then a thick layer of beton is put on and surfaced, made smooth by covering with cement. The asphalt powder is heated in portable furnaces that are wheeled to the spot, and then spread evenly over the beton and compressed by stamping and rolling.

ASPHALT MASTIC.

This remarkable mineral finds still more extensive use for making mastic or asphalt cement. The mass which has been converted into powder, either by heating or by mechanical means, is gradually introduced into a bath of pure melted asphalt that amounts to eight or ten per cent. of the weight of the asphalt powder to be used. This mixture is kept boiling for five or six hours, being constantly stirred all the while. In this way a doughy mass is obtained, which, when cast in blocks, forms the so-called "mastic," a product the particles of which, unlike those of the crude asphalt, are chemically combined so that they cannot be separated again by heat alone.

The manufacture of this mastic now forms an independent branch of industry; in France alone from 15,000 to 20,000 tons are manufactured annually, while the production of imitations and adulterations amounts to ten or twenty times as much. A few years ago the use of mastic was limited to sidewalks and vault covers, but to-day the use of asphalted floors is so common that their preparation has become a regular branch of industry.

USES OF MASTIC.

For walks and floors the ground is smoothed off and stamped down hard, and covered with a layer of beton or lime mortar, and over this is spread a layer of hydraulic lime which is mixed with fine sand to give a perfectly smooth surface. A brick pavement can also serve as the base, but the bricks must be laid in mortar and the cracks well filled, and then have a layer of mortar poured over it. When the foundation has been made and is perfectly dry, iron bars of the same thickness as the asphalt layer are to be laid on it at regular intervals. The asphalt is melted in portable furnaces and mixed with sand, bituminous lime, etc., and then poured out between these bars, each strip being smoothed off and brought to the level of the bar before beginning the next, when the intervening bar is removed. If a rough surface is desired, it is strewn with washed and sifted sand of a uniform size, which is rubbed in with a wooden pounder, and colored patterns can be produced by using broken porcelain or powdered smalt. Mosaic floors can be made in churches, vestibules, dining rooms, etc., by pressing small colored tiles, or burned clay ornaments into the asphaltic mass before it hardens. Verandas, platforms, terraces, and flat roofs are covered with asphalt. By putting some earth upon asphalted terraces the most charming "hanging gardens" can be made. To make the floors of stables, wash rooms, etc., impenetrable to moisture, the pavement can be covered with a layer of asphaltic mastic. The floors, sides, and ceilings of cellars, the arches of tunnels and bridge arches, roofs, chimneys, and walls, as well as other parts of buildings, can be protected against the penetration or ascent of moisture. Canals, water basins, and holders for acid liquids may be lined with brick dipped in the melted asphalt, the mastic being poured into the crevices and joints, then covered with lime mortar, and

over this a layer of asphalt. In foundations for marine structures a sort of asphaltic beton is used, consisting of coarse, sharp stone in mastic.

PIPES AND TUBING.

At the glass-house in Rive-de-Gier, France, glass tubes covered with asphalt are made on a large scale for conducting water as well as gas. Recently asphalt pipes for the same purpose and also for air and blast pipes, and for caustic as well as acid fluids, are made by passing an endless strip of hemp paper, the width of which equals the length of the tube, through melted asphalt, and then rolling tightly and smoothly on a cylinder having the same diameter as the tube is to have inside. When the number of layers of paper is sufficient to give the desired thickness the surface is strewed with fine sand, and a strong pressure is applied to the sides of the tube. After cooling it in cold water the cylinder that serves as a core is drawn out, and the pipe coated on the inside with a water-proof varnish. In addition to being absolutely tight and much cheaper than metal pipes, these pipes have the advantage of strength; pipes of which the walls are scarcely 1½ cm. (three-fifths inch) thick will withstand a pressure of more than fifteen atmospheres, and will not break when the earth settles, nor when shaken and jarred violently. The material being a poor conductor of heat, such pipes are protected against freezing.

ASPHALTIC PAINT.

To the other manifold uses to which asphalt is applied is for sand or gravel and cast in cubical blocks four inches on a side offers considerable resistance to changes of temperature. This led the French engineer Malo to try using such blocks for mounting large machinery. A block twenty-three feet long made of mastic and broken stone has been in use since 1862 as ground plate for a horizontal steam engine of fifty-horse power in a place where the temperature varied between 86° and 122° Fahr., and no change of shape is visible yet. Since that, blocks of asphalt have been used with equal results as foundation for machinery running at high speed; for example, a disintegrator making 1400 revolutions per minute.

FIREPROOF.

Charges were made on many sides that asphalt was dangerous from fire, but in one case it proved an effective protection against fire. About twenty years ago the engineer Malo, already mentioned, had an asphalt floor put down on the second floor of a foundry. One day the floor beams took fire from a stove on the ground floor. The flames threatened to reach the roof of the building, when the charred beams gave way and the asphalt floor, the under surface of which was burning brightly, fell. Then followed a most unexpected occurrence. The layer of asphalt, softened by the great heat, and falling as a single mass, enveloped the stove as with a mantle and extinguished the flame.

FROM A SCIENTIFIC STANDPOINT.

The peculiarities of asphalt which make it capable of so

EVILS AND ADVANTAGES OF ASPHALT PAVEMENTS.

The advantages of asphalt pavement, as proved by practice, over ordinary pavements are, first of all, the easy and noiseless manner in which vehicles move over it, and the slight amount of dust and dirt, and the sanitary advantages that result from this cleanliness. The disadvantages, on the other hand, are that it is slippery and dangerous for horses in damp weather, and consequently it is inadmissible on grades above 1 in 50; also the necessity of frequently destroying the asphalt layer to get access to the gas and water pipes, and the relative frequency of repairs. Although these evils are undeniable, still they cannot be considered as inevitable; and although some of them have recently made their appearance in a very disagreeable manner, they should not be laid to the charge of the system itself. In this respect the most dangerous, perhaps, is the slipping of horses; for when there is fog or fine rain the unavoidable street dust is converted into an unctuous, smeary substance, which renders the surface of the street slippery until it is removed by a heavy rain that washes it all off. This evil is somewhat mitigated by the fact that the asphalt pavement is so elastic that when a horse falls he is not generally injured as badly as when he falls on macadamized or paved streets.

It may be worth mentioning as a curious fact as the result of Engineer Darey's calculations that the injury to wagons and teams and the cost for wear and tear is reduced to one-half on asphalted streets, and in a city like Paris this would make an annual saving of nine million francs ($1,800,000).

The necessity of destroying the asphalt to gain access to

SUGGESTIONS IN ARCHITECTURE.--OLD HOUSE, HEREFORD.—DRAWN BY R. KNILL FREEMAN, F.R.I.B.A.—*From The Architect*

coating wooden and iron articles to protect them from the influence of the weather, impregnating felt and pasteboard to make it water-proof, for insulating subterranean telegraph wires, as etching ground for etching glass and copper, as a brownish black paint in oil painting, and for supports for pillars, etc.; but these only hold in cold rooms. Packing paper soaked in melted asphalt serves as substitute for wax paper. What is called double paper, used for covering damp walls, is made by putting together two thicknesses of paper asphalted on only one side.

IN PHOTOGRAPHY.

Asphalt is also employed in photography and phototypy. Niepce, the real inventor of photography, discovered that this substance was sensitive to light, and produced light pictures by making use of the peculiarity of thin layers of asphalt to lose their solubility in essential oils when exposed to light. The asphalt process is used to-day in a more perfect form in printing bank notes.

Although the practical uses of asphalt seem already to be so many sided, still the attentive observation of the properties of this mineral are continually leading to new uses.

UNDER MACHINERY.

Experience has shown that although a thin layer of asphalt spread out upon a footpath or floor is brittle when cold and too yielding when hot, so that injury to its form can only be prevented by strewing gravel on it, yet asphalt mixed with many technical uses would seem to offer an interesting subject for scientific study, yet in this as in many other cases the latter are far behind the achievements and acquirements of practical experience. With the exception of a few chemists and geologists who have considered it only as a mineralogical curiosity, each from his own particular point of view, scientific men have hitherto, strangely enough, been quite indifferent to its study.

Asphalt has been compelled very gradually and imperceptibly to conquer the position that it now holds, especially as a building material, by perpetually repeated practical tests, and even in the face of numerous practical results this material is looked upon with suspicion by many. Such mistrust is at least apparently justified, for there is scarcely any other substance of practical use that is exposed to so much adulteration and deterioration. In fact, it required years of experience in the preparation and use of asphalt to be able to decide with certainty which of two minerals, immediately after they had been brought out of the quarries, was the best suited for use in every case. Very frequently the so-called artificial or German asphalt—that is, coal-tar pitch—is used instead of genuine asphalt. This is the substance left behind in the retort in distilling coal-tar, and in many respects it resembles natural asphalt so much that it can replace it for many purposes. But in all cases where it is desirable to have a perfectly even, smooth, and waterproof surface that is somewhat elastic, asphalt is to be preferred to all other materials.

gas and water pipes must also be acknowledged at present; but this evil will probably be overcome some time, for at no very distant period all large cities must follow the example of London, and put these pipes in sewers or subways.

The third objection, the "incessant" repairs, which are a serious obstruction to travel as well as a heavy drain on the city budget, has hitherto been referable to two chief causes: first, neglect of the precaution of putting the warm asphalt powder down on a thoroughly dry, solid, and impermeable foundation; and secondly, to the use of improper, unsuitable, or badly prepared material. Increasing the thickness of the layer of béton to 10 inches cannot be too strongly urged as a protection against the injury that may result to the asphalt from leaks in the gas pipes, for the escaping gas softens the asphalt.

With regard to the future importance of asphalt in the industrial arts, it is safe to assume that in proportion as it becomes better known the use of it for the greatest variety of purposes, but especially for street making, will become more popular.

ASPHALT IN NEW YORK.

In Paris, says the *Popular Science Monthly*, there are 33 miles of streets paved with asphalt, while New York city can boast of only a few small and isolated strips of such pavement. In front of the Brevoort House and the Hotel Brunswick the compressed asphalt, so popular in Paris, may be seen and tested. Imported mastics are quite

extensively employed for sidewalks, and may be seen in many of our parks, such as Tompkins Square, Reservoir Park (outside), court of N. Y. Hospital in 15th Street, etc. It is also used in stables and breweries, and most of the new fire proof buildings. At the present writing the method of boiling and mixing mastic for floors and roofs can be conveniently seen in 42d Street, near Fifth Avenue. The new chemical laboratory of the New York Gas Light Company in East 21st Street has a floor of asphalt mastic.

The form of asphalt street pavement most popular in this country, and apparently best suited to our climate, is that known as "Trinidad." It is made of prepared bitumen, *i. e.*, Trinidad asphalt and "still-bottoms" from petroleum works, mixed with about twice its weight of calcareous marl or powdered limestone, and boiled. No imported rock or mastic is added; hence it is much cheaper than the other forms. A piece of it was laid last year in 15th Street, between Fifth and Sixth Avenues. In Washington, D. C., there are more than forty miles of it.

ASBESTOS AND ITS APPLICATIONS.

ASBESTOS, a Greek word signifying "unconsumable," is the name given to a peculiar variety of the amphibole or hornblende family of minerals, of which the chemical composition is chiefly silica, magnesia, alumina, and ferrous oxide. It is most common in Canada and Italy, but in one form or another is also met with in considerable quantities in certain parts of Scotland, in Sweden, Corsica, the Ural Mountains, and Australia. But little appears to be known as to the formation of asbestos. It occurs in regular layers or veins, and, as found, is generally a grayish-green rock made up of innumerable fine crystalline fibers which become soft, white, and of a silky luster when separated from each other by slight pressure. The thickness of the veins varies considerably in different localities, from a thin sheet in the case of the variety known as mountain leather to several inches in the deposits of the delicate amianthus found in the older crystalline rocks, in the Pyrenees, the Alps of Dauphiny, the St. Gothard, the Savoy, and Corsica. A single fiber of asbestos, heated in the flame of a blowpipe, readily fuses to a white enamel, the varieties containing most iron being more easily fused, but in the mass it resists the heat of an ordinary flame, and for this reason it has recently begun to attract considerable attention. Unfortunately, the fibers of asbestos differ from all other known fibers in having a perfectly smooth surface and in being much less elastic than those of either animal or vegetable origin, in consequence of which all efforts to spin and weave them by modern machinery have until very recently entirely failed. In ancient times, however, the art of weaving asbestos into all sorts of useful drapery and dress material seems to have been well known, although it is possible that this was accomplished by spinning the fibers along with those of flax, and then destroying the latter by heat, a process still resorted to by some makers. At any rate, it is stated that the bodies of the dead used to be wrapped in asbestos cloth to keep the ashes separate from those of the surrounding funeral pile, and at a later date it is said that Charlemagne had a table-cloth woven from amianthus, which he used to have thrown into the fire after dinner, to the astonishment of his guests. Chevalier Aldini, of Milan, had a complete dress with cap, tunic, gloves, and stockings made of asbestos cloth, and carried out very successful experiments by way of testing it as a protection for firemen.

In addition to amianthus and mountain leather, there are several other varieties of asbestos. We will, however, only name mountain cork, which is a brownish or dirty white deposit, less flexible and less regular than amianthus and mountain leather, and which is so light as to float on water; mountain wood, a soft, opaque, brownish colored variety, which melts to a black slag before the blow-pipe; and lastly, the common asbestos which has recently been discovered in large quantities in Canada, in veins from 1 in. to 2 in. thick, and which is the kind most generally used for manufacturing the various articles to which we shall have occasion to refer.

The introduction of asbestos for such purposes as engine packing and jointing for pipes has been attended with very considerable difficulty. Of all materials it is perhaps that which requires the most careful manufacture and intelligence in adapting it to its special purposes, and when these have not been sufficiently exercised users have been disappointed, and have not unfrequently given up the trial in disgust. As with many new and important substances, asbestos has been looked upon by some as a sort of panacea, and recommended as such, while others have been so eager to sell that failure has often occurred from the use of some specially prepared form in a situation where those better acquainted with the trade would have known beforehand that it was totally inapplicable.

Having recently had an opportunity of inspecting the large asbestos manufactory of Mr. John Bell, we now propose to describe some of the more important uses to which this interesting material is being applied. Mr. Bell, though not the first to introduce asbestos goods into this country, has perhaps done more than any other person in developing the use of pure asbestos in all the multifarious branches to which it is now found to be applicable, and it is likely that before long further important developments will be made as the result of experiments which have been in progress for some time, and which are now being brought to a successful issue.

As we have before stated, the peculiarity incidental to asbestos fiber for a long time baffled all attempts to spin it into a yarn without the intermixture of a certain proportion of flax or other vegetable fiber, which of course could only be looked upon as an objectionable adulteration, and was only to be tolerated until other and better means could be discovered. Within the last few years, however, the difficulty has been overcome and yarns capable of withstanding great tensile stresses can now be readily produced by machinery which has been specially constructed for the purpose. One of the most important applications of this yarn is for the manufacture of steam packings, of which a great variety are made, each description being designed to meet some special demand. In making packing it was at first not sufficiently recognized that the fibers of asbestos were apt to be largely charged with minute particles of pyrites, and until this fact was appreciated it was often found that the piston-rods were scored, the damage being attributed to the action of the asbestos itself, instead of to the impurities it contained. To obviate this defect it therefore became necessary, not only to carefully select the most suitable kind of asbestos for the purpose, but to thoroughly cleanse it from all stone and grit before spinning, for which duty machinery had to be adapted. The yarn now produced is quite pure and is capable of being woven into almost any kind of fabric. Fig. 1 shows the most common form of packing, in which the pure asbestos yarn is simply plaited up by machinery into a square or round rope, and for some time this was considered to be the *ne plus ultra*. It was first brought out by Mr. Bell in the year 1879, and was immediately adopted by the British and German navies, where its use is still continued. But it was soon ascertained that special cases required special treatment, and though the plaited packing was generally satisfactory, it became evident that something else was wanted in the case of steam engines with extremely high piston speeds, such as are now being introduced into the merchant service. To meet this demand the yarn was first woven into a cloth which, being slightly waterproofed with vulcanized India-rubber, was rolled up into a rope in much the same way as the canvas is treated in what is known as Tuck's packing, only without the rubber core. This packing, which is shown in Fig. 2, answered admirably, and is being much used in cases where the rapid destruction of ordinary packings gave rise to most serious inconvenience. In addition to the two varieties here mentioned, other forms are

FIG. 1

FIG. 2

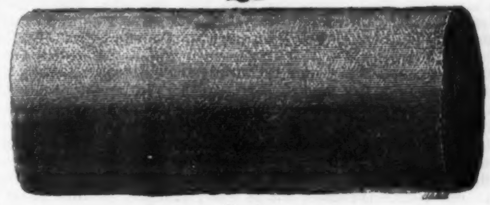
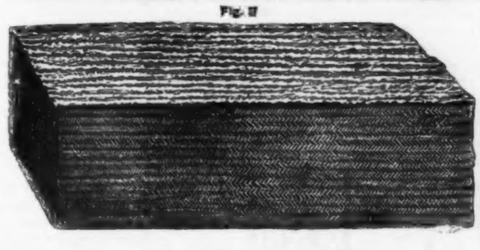


FIG. 3



made, asbestos with soapstone being found to be excellent for locomotive work, while a more elastic packing, shown in Fig. 3, in which a core or internal band of India-rubber is introduced, is giving great satisfaction in the large glands of marine engines and other similar cases. This latter form has been designed to overcome the difficulties met with in working with steam of very high pressure, the economical advantages of which cannot be realized without a much more durable packing than most of those generally used. The enduring powers of this asbestos block packing are quite remarkable. In one case, on being taken out after twelve months, working with steam of 70 lb. pressure, it was found to be perfectly good, and was accordingly replaced, while as an instance of its efficiency we can cite a case in which, after uselessly trying almost every kind of packing in a troublesome stuffing-box of a large pumping engine, the asbestos block packing was found to answer admirably, and the result has been that an average of 1½ lb. to 2 lb. better vacuum has since been maintained in the cylinder.

It has often been erroneously stated that asbestos packing could be used without lubrication. No greater mistake could exist. It not only requires a good supply of o' but demands careful attention on the part of the engi-

FIG. 4

neer in charge. With these it invariably gives satisfaction, and will last from five to ten times as long as ordinary packing, while without these it inevitably disappoints. In other words, if carefully manufactured and properly used, asbestos is the best material for packing the glands of steam engines; but if ignorantly made up and carelessly used, it is probably the worst.

A great deal of yarn is woven into cloth, the increased use of which has been very marked during the last twelve months, and which is being adopted for a great variety of purposes. One noteworthy application is for fireproof curtains, and several of these have been supplied by Mr. Bell, for theaters in Great Britain, the United States, and some of the principal cities in Europe. Curiously enough, our Yankee cousins have not yet succeeded in spinning an asbestos yarn without admixture with vegetable fiber, and they have therefore been compelled to obtain all their cloth from Mr. Bell. So important, however, do they consider this material in regard to the prevention of the spread of conflagrations, that a company has been formed in New York, with the sole object of extending its use in the shape of protective shields, either permanently fixed or applied in case of a sudden emergency. In relation to this application a fire shield was recently exhibited at a meeting of the Firemen's Convention held at Rochester, N. Y., and attracted very great attention. The shield consisted of a piece of pure asbestos cloth about 20 feet square, and supported on an iron fame. A pile of pinewood saturated with petroleum and tar was built on the windward side of the curtain and set on fire. The blaze was tremendous, and the heat so intense that persons could not stand within 50 feet of the burning mass on the exposed side. On the side protected by the shield, however, the heat was scarcely felt, and a dummy erection of wood and glass, which was placed close beside it, was not in any way injured. The curtain, of course, did not suffer, and was as good after the experiment as it was before. This asbestos cloth might be used in many ways to protect property from destruction by fire. A curtain suspended from the cornice of a building might be lowered in an emergency and effectually screen the entire front, and many industries where there is danger from fire, might also be protected by lining the rooms where such dangerous work is done, with asbestos cloth.

Another interesting application is in the filter invented by Mr. Maignen. This apparatus consists of a hollow perforated cone of earthenware, over which is stretched a specially woven asbestos cloth. On the outside a layer of the finely powdered filtering medium—Maignen's patent carbo-calcis—is automatically deposited by being mixed with the first water put into the filter. To cleanse the whole thing all that is required is to wash off the old filtering medium and deposit a fresh supply on the asbestos cloth, an operation very easily accomplished in a few minutes, and one which can be done without the trouble and expense of returning the filter to the makers.

For forming the joints of pipes exposed to the action of moisture, and for man and mudhole doors requiring frequent removal, asbestos woven cloth is very largely in demand. In these cases asbestos millboard, which is the cheapest form of jointing material, is comparatively worthless, if, indeed, it is not absolutely objectionable, from its permeability to water, which soaks through and attacks the iron of the bolts, and it was, therefore, necessary to devise a combination which would effectually resist the heat and damp. This is provided in what is known as asbestos and India-rubber woven sheeting, which is made in any thickness, and is supplied either in sheets cut to the required shape, or in a tape 1 in. to 2 in. wide, which can be cut to length and bent to circle or oval without puckering. When all other materials have failed to give satisfaction, this has anwered admirably, and in the case of manhole and mudhole doors and feed-water pipes the joint can be broken twenty times without requiring renewal of the strip. The last application of the yarn which we shall mention, though the list is not exhausted, is in the manufacture of rope and cord. Having great tensile strength, and being unaffected by heat and damp, this material is being introduced for sash lines and for ropes of fire escapes. It is also adopted for covering rollers in print works, especially when aniline dyes are used, and in cases when it is exposed to great heat and to the action of hydrochloric acid. Asbestos cord has also been found to be the most effectual material for making the joints of the hot-air pipes for blast furnaces, which are exposed to an exceedingly high temperature. The jointing piece is shown in Fig. 4, and consists of an iron ring wrapped with the cord, which is simply put in place and nipped between two flanges. Previous to the manufacture of asbestos cord the rings were wrapped with spun yarn, which gave continual trouble, while the asbestos, being unaffected by heat, lasts a very long time.

We now come to an entirely different manufacture of asbestos, in which the rock, after being broken down and reduced to fluff, is pulped and formed by pressure into sheets from $\frac{1}{64}$ in. to ½ in. in thickness. This millboard, as it is called, is used for making joints not exposed to the action of moisture, such as for dry steam, air, and gas. Much of the millboard in the market is made of very inferior matereal, chiefly waste cuttings and second hand stuff, and, being devoid of long fiber, it is insufficiently bound together and soon disintegrates, while a great deal of that imported from abroad is impure, and contains as much as 10 per cent. of adulteration. When properly made and used with faced surfaces, this material affords the easiest and most cleanly method of making a joint that we know of, while if the faces are previously painted over with boiled oil the danger of having a troublesome leaky joint is reduced to a minimum. The board is easily cut to the desired size, and as no time is required for drying and setting, steam can be turned on directly the bolts are screwed up. We speak from experience when we say that with no material with which we are acquainted can dry steam and air joints be made with more ease and certainty as with asbestos millboard.

A much commoner and cheaper description, though it still possesses most of the essential qualities, is manufactured for fireproofing floors and ceilings. It is made in sheets about $\frac{1}{16}$ in. thick, and is applied in the simplest possible way either above or below the joists. It is also used for lining the walls of wooden buildings, where from its non-conducting and fireproof qualities it affords an immense protection in case of the outbreak of fire. For surrounding flues or covering the parts of a building exposed to the action of heat, or in the neighborhood of a fire, it is also valuable. The step from millboard $\frac{1}{64}$ in. thick to paper is apparently so small that it is not to be wondered at that many attempts have been made to produce an asbestos writing paper, which, from its indestructibility, would be invaluable in case of fire, for preserving charters, policies, agreements, and other important documents. So far, however, these efforts have not been successful, for though a paper has been made it has been too uneven in texture, and altogether too rough and akin to blotting paper to permit of its use as a writing material.

As an insulator of electricity asbestos in one form or another is greatly sought after. Millboard has for some time been used in the construction of dynamos, while cables and leads covered with plaited yarn have been adopted in many installations. The advantage of having as an insulator a material unacted upon by heat or damp is so obvious, that we venture to think there is a large future open to asbestos in this branch of electric work. Cheapness of production is, however, essential, as it will be brought into competition with materials which, though not possessing all its advantages, are more easily procurable and require less special adaptation in their manufacture.

The remaining uses of asbestos which we have to notice appear to be mainly in the production of fireproof cement and putty, for which there is considerable demand for certain kinds of joints, and in the manufacture of fire and acid-proof lumps, blocks, and bricks. The ordinary gas fire is familiar to every one, and it will suffice to point out that asbestos enters largely into the composition of the arti-

ficial fuel upon which the success of the fire in a great measure depends.

In conclusion, we will just say that we have been tempted to dwell rather fully on the nature and applications of this interesting mineral, as we believe that they are not generally known to our readers, and also because we feel sure it is very seldom that enough care is exercised in the selection of a packing or jointing piece, anything cheap and handy being used, whereas there can be no doubt that to make a satisfactory joint, either for a stuffing box or pipe-flange, it is necessary to apply a considerable amount of discrimination in the selection of the material.—*The Engineer.*

DICTIONARY OF CARRIAGE TERMS.

Britton Buggy.—A modernized form of the Goddard Buggy (*q. v.*), mainly distinguished from the Corning buggy by having a drop front.

Corning Buggy.—A modernized form of coal box buggy, with cut down front, deep sides, and moulded panels on both body and seat; it is hung on either side bars or elliptic springs. When made with a close top, it forms a convenient physician's phaeton.

Surrey Cart.—An English form of dog cart, characterized by a Whitechapel body (*q. v.*), surmounted by a railing supported by spindles.

Surrey Wagon.—An American modification of the English Surrey cart (*q. v.*), the same pattern of body being hung on four wheels.

Truck.—A heavy freighting vehicle, with platform body, without side panels, and either two or four wheels.

Tub Body.—A carriage body characterized by a short, curved bottom line, and deep, heavy quarter.

Tub Phaeton.—A phaeton having a tub body (*q. v*).

Upset.—French, *refouler;* German, *Stauchen.* A technical term used to describe the process of shortening a bar of iron by end pressure; especially applied to tires and axles.

Upsetting Machine.—French, *machine à refouler;* German, *Stauchmaschine.* A machine specially designed for contracting tires without cutting or welding.

Valance.—I. French, *entre-deux;* German, *Sitzborte.* The patent leather trimming surrounding the driving seat board. II. French, *jupe* or *volant;* German. *Verdeckborte.* The strip of cloth or leather, placed around the roof of light standing tops, inside, as an ornament. No open tops are made in Germany.

Varnish.—French, *vernis;* German, *Lack.* A transparent liquid, composed mainly of oil, gum, and turpentine, applied with a brush, giving a hard, glossy surface.

Venetian Blind.—French, *jalousie;* German, *Venetianischer Vorhang.* A blind made of movable slats, set in a frame, capable of being opened or closed by the movement of a cord, applied to carriage windows to screen the occupant from observation or sunshine, and at the same time admit air.

Victoria.—French, *victoria;* German, *Victoria.* Derivation: Named by the French in honor of Queen Victoria. A member of the coach family. *History:* The Victoria is a form of the modern four-wheeled cabriolet (*q. v.*), from which it chiefly differs in having a skeleton instead of a paneled boot. The Victoria is the more stately form of the cabriolet, and, in its full development, is driven with postilions. In its more common form the boot is restored, or is sometimes movable and a rumble is added. *Mechanical description:* The Victoria is a four-wheeled vehicle, with a cabriolet body and hood, and with a skeleton boot, usually movable; and it is generally suspended on elliptic and C springs.

Vinaigrette.—A rolling chair used in Paris in the last century, called also roulette and brouette (see the latter), having a body like that of the Sedan chair, but resting on springs and two wheels, and drawn by a man. See description in Roubo, page 460, and illustration, plate 219.

Vis-à-vis.—Derivation: French, *vis-à-vis*, meaning face to face. A member of the coach family. A term which might be applied in general to all vehicles whose seats are arranged crosswise, and so that the occupants sit face to face. The French, in the course of cutting down the coach in various forms, as fully described under "Coupé" (*q. v.*), halved the coach longitudinally, and called the resulting vehicle, which accommodated two persons only, sitting face to face, a vis-à-vis. Since that time the term has been applied to various other vehicles characterized by the same manner of seating.

Volante.—A two wheel vehicle peculiar to Cuba, characterized by a chaise body, hung forward of the axle, and driven by postilion.

Wagon.—Derivation: From the German, *wagen*, to move. A term applied to the most primitive or spontaneous form of conveyance. It is a four wheeled vehicle, either with or without springs. The family of wagons is a large one, and includes many varying classes of types, such as the farm wagon, market wagon, road wagon or buggy (*q. v.*), Whitechapel, Windsor, Surrey, and Buckboard.

Wagonet.—A general term applied to all vehicles provided with two longitudinal seat boards, where the passengers sit face to face, and where the entrance is from the rear. The form, shape, and size of the body, the form and arrangement of the driver's seat, and the presence or absence of a top, may vary the style infinitely, but the vehicle is still a true wagonet so long as the above named characteristics remain. The French term *char à-bancs*—literally a carriage with bench seats—is the equivalent of the English term wagonet in this technical sense. See "Seating."

Wear Iron.—French, *plaque d'arrêt* or *butoir;* German, *Aufhaltplatte.* An iron plate fastened to a carriage body, at points where the wheels are liable to strike to prevent injury to the body.

Webbing.—French, *sangle;* German, *Nachtschnur.* A strong hempen band used to connect the bows, and hold them in place; also placed over springs in cushions to secure them.

Welting.—French, *jonc;* German, *Besatz.* Strips of leather bound around cord, used for ornamenting the edges of cushions and other parts of the trimming.

Whiffletree.—(Spelled also whippletree.) French, *palonnier;* German, *Ortscheit.* A movable bar, attached to the cross draw bar of a carriage (in buggies, the shaft bar; in four-in-hand driving, the evener bar), to the ends of which the traces of the harness are secured.

Whipsocket.—French, *étui de fouet;* German, *Peitschenstiefel.* A tube, made of leather, metal, or gutta-percha, attached to the dasher or driving seat, in which the whip is placed when not in use.

Whiskey.—Derivation: Supposed to have been so called on account of its ability to *whisk* or turn around easily. The whiskey was an early form of chaise, being a light two wheeled vehicle, hung on grasshopper springs, without hood or top, and very similar to our modern sulky in its general appearance. For illustration and description, see Felton.

Whitechapel Cart.—An English form of dog cart, characterized by a deep, square box body and bracket front.

Whitechapel Wagon.—An American modification of the English Whitechapel cart (*q. v.*), the same pattern of body being hung on four wheels.

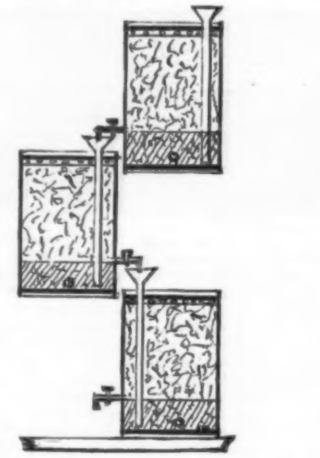
Window Lifter.—I. French, *cordon de glace;* German, *Aufzugriemen.* Same as glass string, *q. v.* II. French, *crochet de glace;* German, *Fensteraufzug.* A curved piece of metal, or a button or hook, by which the windows may be raised or lowered.

Windsor Wagon.—A term applied to a particular form of American square box buggy, hung on cross springs and side bars.

Wourst.—Derivation: German, *Wurst*, a sausage. A long, sinuous hunting wagon, so called from its supposed resemblance to a sausage. It consisted of four wheels and a very long perch, with an extended seat or saddle following the perch, on which the hunters sat astride. Its shape was supposed to allow it to make its way more readily through the woods.—*The Hub.*

VINEGAR MAKING.

The accompanying illustration shows the arrangements of the Hengstenberg generators. The stock mixture is contained in a reservoir situated above the generators. The generators, of which there may be from three to seven, stand vertically one above the other as stated. In the morning the upper generator cask is filled with the stock mixture from the reservoir, and as soon as it is filled, the faucet near the bottom of the upper cask is opened and the stock mixture allowed to fill the next lower generator cask. From this the stock mixture is drawn over the next lower cask and so on to the lowest one, so that every generator cask has been completely filled with the stock mixture for a short time. The faucets have an extra wide bore, so that the flow from one cask into the other takes the least possible time; they remain open after the liquid has flowed off and thus are the means for the admission of air into the casks. The shavings with which the casks are filled are completely and uniformly soaked with the stock mixture, and dry places or nests, which often cause great troubles and irregularities in other systems, are an absolute impossibility with this system. The formation and spreading of disease, and more especially the propagation of the so-called vinegar flies, is prevented in this system. After the mixture has arrived in the lowest cask, about one fifth to one-fourth is racked off as ready vinegar, so that if six



generators of 150 gallons capacity are worked together daily, from 25 to 30 gallons of ready vinegar are drawn off. The balance of the stock mixture is now brought back to the reservoir, and enough fresh stock mixture is added to fill the same up. It remains there till the next morning, when it is carried through the same circuit in the same manner as above described. It is evident that the labor is very simple the opening and closing of the faucets may be attended to by an apprentice, and the lifting of the stock mixture to the reservoir may be done by any common and untrained laborer, if, as it naturally would be in larger establishments, a pump is not preferred for this purpose. The building for a vinegar factory worked on this plan does not require any special appointments, and therefore any locality may be utilized, and such buildings having rooms from eight to ten feet high, one above the other, are very well adapted for arrangements on a larger scale. In every story two or three casks can be placed in such a manner that the lower cask in the upper story connects with upper casks of the next lower story by means of a piece of rubber hose, which is drawn over the faucet key and passes through a two-inch hole in the floor. The reservoir should be in the form of flat tubs (storage casks sawed in two will serve very well), and are placed in the top story, where it is warmest, and where the acidification of the stock mixture remains in constant activity.

The Hengstenberg system of generating vinegar, on the whole, offers some advantages, but it would appear to us that these advantages can be fully utilized only by works of comparatively small capacity, and that for yield in quantity and strength it cannot compete with the Schuetzenbach generators if the same are worked by expert hands and under proper conditions. Nevertheless the progressive manufacturer will not lose anything by trying a set of small generators of this kind; it may be got up with almost no expense at all from a few odd barrels and faucets, and as it can be run regardless of interruptions, it may do good service in the production of one or the other fancy brands of vinegar, which to produce it is sometimes very desirable, although it would not be advisable to attempt the same by interrupting the working of a large generator.—*Chem. Review.*

CRUCIBLES OF NICKEL.

M. Mermet recommends the use of nickel crucibles instead of silver in chemical manipulations. They are slightly attacked, it is true, by melted potash, but silver itself is not indifferent to this action. They cost at first much less than silver, and moreover they have the great advantage of melting at a higher temperature. It often happens, in fact, that inexperienced chemists melt their silver crucibles in heating them over a gas lamp; such an accident is not to be feared with nickel crucibles.

SYNTHESIS OF ORGANIC COMPOUNDS.

Messrs. A. Bartoli and G. Papasogli have recently published the results of their inquiries in this field, and they possess considerable interest The electrodes which they employed were either graphite from different sources, retort carbon, or wood charcoal purified with chlorine at a high temperature. When water was employed as an electrolyte, a very strong battery—1200 Daniells—was employed to overcome the resistance. After the lapse of two days the water had acquired a brown color and a slight acid reaction, in consequence of which it conducted the current more readily, and the battery was changed for one of 100 elements, and after the lapse of ten days it sufficed to employ twenty elements, and this current was transmitted for another thirty days. After this time the water was almost black in color; the carbon electrodes, which weighed about 500 grammes, were completely disintegrated, and the bottom of the vessel was covered with a layer of thick, black, pulverulent matter. In the liquid could be recognized mellitic acid and the derivatives of this acid, for instance hydromellitic acid, pyromellitic acid, and hydropyromellitic acid. This acid occurs in combination with alumina, as a crystallized mineral, mellite or honeystone, in the brown coal of Artern, in Thuringia, and at other localities. And the acid was a few years ago prepared artificially by the action of potash permanganate on charcoal. At the bottom of the vessel, besides the broken-up pieces of graphite, was found a black substance, which is soluble in warm water and in alkalies, but is not taken up by the mineral acids and by other solvents. The authors have called this mellogen, because when oxidized it yields acids of the benzo-carbon series. Pure mellogen is solid, black, highly lustrous, soluble in water, alkalies, and sulphuric mono-hydrate, but throw down again from that acid by the addition of water. It is insoluble in ether, alcohol, chloroform, carbon disulphide, benzol, etc. It does not melt, is burnt with difficulty, does not crystallize, and exhibits a good array of colors. Its aqueous solution is thrown down by acids and mineral salts. These precipitates consist, as a rule, of pure mellogen; only those thrown down with the salts of copper, lead, and baryta are true compounds. The most remarkable property possessed by this body is that it readily combines with oxygen, and, as already stated, forms acids of the benzo-carbon series. If a watery solution of mellogen be exposed to the air it becomes acid, and mellitic acid is formed. The best oxidizing material is sodic hypochlorite, which is without action on graphite and retort carbon, which readily dissolves mellogen with a great disengagement of heat. Mellogen dried at ordinary temperature loses water at 130 deg.; between 130 deg. and 170 deg. no further change is noticed; at higher temperatures water is again given off, and the whole is lost. The analysis of mellogen shows it to have the formula $C_{11}H_2O_4$, and the constitution of the barytic salt is shown to be $C_{11}HBaO_4$. If in place of distilled water an alkaline solution—hydrate or carbonate—be used as an electrolyte, there is always found after a few days a considerable quantity of mellitic acid and allied bodies, but very little mellogen. On the other hand, by employing acid electrolytes—sulphuric acid, nitric acid, hydrochloric acid, formic acid, acetic acid, and oxalic acid—the first-mentioned products are only sparsely found. The mellogen, on the other hand, is very plentiful. With phosphoric acid another result is obtained, for in this case the mellogen combines with the phosphorus to form phosphor-mellogen. The gases escaping from the poles were examined. At the negative pole there was always a development of large excess of hydrogen, at the positive pole a mixture of carbonic acid, carbonic oxide, and some oxygen. Phenol—carbolic acid—dissolved in potash, when treated in the same way, was almost completely converted into a substance which remained dissolved in the alkaline liquids. It is insoluble in acids, ether, and benzol, soluble in carbon disulphide, is black, uncrystallizable, and infusible. Analysis gave the numbers $C = 66{\cdot}01$, $H = 4{\cdot}18$, and $O = 29{\cdot}81$. Copper solution is reduced by this body, which, when boiled with acid water, splits up into two substances.

SEA SALT.

By William Jago, F.C.S.

Take a glass of sea water, set beside it another filled with the purest water to be obtained; observe the two most carefully; to the sight, at least, they present no difference; one might as readily be taken as the other, and emptied at a draught on a hot summer's day, yet all know that while the latter is the most precious boon to a thirsty man, to offer the former would be a cruel mockery; its contents are undrinkable, the water is—salt. Water acts as an almost universal solvent, and as a result of this property, is never found pure in nature; the sea, as the great reservoir into which rivers are continually pouring their contents, acts also as the receptacle of the solid matter they have dissolved from the cocks and moorland over which they have passed in their course.

The sun, acting on the ocean's surface, vaporizes water only; through the cycle of cloud, mist, and rain, it is again borne to earth, and once more commences its downward flow oceanward, carrying with it another burden silently stolen from river banks, and as silently leaving its load with the sea as it goes on to repeat its mission in cloud and shower. In this way the sea acquires its characteristic saltness through the gradual transference, by the agency of rivers, of the soluble matter of land to itself.

The saltness of the sea is not the result of the solution of one substance alone; although by far the greater part of the solid residue left on evaporating a sample of sea water to dryness consists of salt proper (common salt or sodium chloride, NaCl of the chemist), there are several other ingredients also present. Among these may be mentioned magnesium chloride and bromide, calcium sulphate and carbonate, besides traces of other substances. The presence of magnesium chloride may be noticed by tasting sea water; it will be observed that it has, in addition to the simply saline taste of pure salt, a bitter flavor. This is much intensified by evaporating a quantity of the water almost to dryness; the salt, being less soluble, crystallizes out, and leaves an intensely bitter solution of the more soluble magnesium chloride. To this solution, to which we shall again refer, the name of *bittern* is given.

The quantity of calcium sulphate in sea water amounts to a little over one part per 1,000, yet, although so small, it is sufficient to produce vast effects in Nature, as when, for instance, through an alteration in the configuration of the land, a portion of the sea is changed into an inland lake, and then slowly evaporated; beds of rock-salt are thus formed, interstratified with layers of gypsum, which is but crystallized calcium sulphate. As the substances dissolved in sea

water must necessarily have come from the land, and as the igneous rocks must have furnished the first material to be weathered and ground down into sediment, it is interesting to trace the presence of the same elements in these primary rock masses. Igneous rocks by their decomposition furnish two classes of bodies; those of one of these are insoluble, and comprise sand, which is mostly pure silica and clay—a silicate of alumina; among the soluble bodies are compounds of sodium, potassium, magnesium, and calcium. These are also present in sea water.

The presence of common salt in granite may be easily proved by a striking experiment. Take a few fragments of the rock, and crush them to powder in a clean iron mortar, or else on a clean surface, with a hammer, transfer the powder thus obtained to a test tube, and add distilled water, boil, and pass the solution through a filter paper. Evaporate a few drops to dryness on a clean glass slip: a sensible residue remains. To another portion add a few drops of silver nitrate solution; the production of a white precipitate of silver chloride proves the presence of a soluble chloride in the rock. Viewed under the microscope, many samples of granite show themselves to be full of minute cavities, in many cases partly filled with a saturated salt solution.

Before leaving the historic chemistry of sea salt, taught us by geology, a very remarkable property of sea water, as distinguished from fresh water, may be mentioned. Select two glass vessels of similar size and shape (tall gas jars answer admirably), put into each a couple of ounces of dried mud, the finer the better, and fill the one with fresh, the other with salt water; shake them both thoroughly and then set aside. The mud will be deposited as a sediment from the sea water, leaving the upper liquid clear, in a fraction of the time necessary to effect the same with the fresh water. This is no doubt one reason why many rivers deposit their mud as a delta immediately at their mouths, rather than carry it out and allow it to settle for a much further distance over the sea-bottom.

At one time the extraction of salt from sea water was carried on largely on the southern shores of England. Although the working of the vast salt deposits of Cheshire has now, with us, superseded this industry, yet in the south of Europe the process is still solely employed. Shallow pools are constructed at high-water mark, the salt water is allowed to evaporate in them; and, from to time, as they form, the thin crusts of salt are raked off: these constitute the *bay-salt* of commerce.

After as much salt as possible has thus been obtained, the remaining water, or bittern, is employed as a source from which other substances are prepared, the most important of these being bromine. The presence of this peculiar element in sea water may be proved by the following experiment. Pour some three or four ounces of sea water in a six or eight ounce stoppered bottle, and add a few drops of pure sulphuric acid, and then some of a solution of potassium permanganate; the superb violet color of this latter compound disappears almost immediately, giving place to a deep sherry color; at the same time the liquid acquires a most pungent and irritating odor. Notice, too, that the upper part of the bottle is filled with a reddish tinted vapor. The addition of the potassium permanganate has produced a chemical change in which free bromine has been liberated; the color and odor are due to the presence of this element in the free state. There is yet another element present in sea water very similar to bromine, but this exists in the merest traces—its name is iodine. Its extraction is, however, performed for us by certain sea weeds. These absorb the compound of sodium and iodine, and store it in their tissues; the sea weed is dried in the sun and afterward burnt, the sodium iodide can then be dissolved out from the ash by water. The three elements—chlorine, bromine, and iodine—to whose presence in sea water we have referred, form a most interesting group, to which, from their forming bodies very much like salt, the name of "halogens" has been given. We propose in our next paper to describe some experiments illustrative of their properties, and through these to explain the modes of their extraction from sea water.—*Knowledge.*

DETECTION OF UREA.

By C. L. BLOXAM.

A WEAK solution of urea or its nitrate in water presents a difficult problem to the analyst. I have found the following methods very useful in solving it:

Cyanuric Acid Test.—Ascertain, by testing for nitric acid, whether the nitrate is to be suspected; if so, mix the solution with a few drops of the solution of NH_4Cl; but if no nitric acid be found, acidify the solution with HCl. Evaporate the solution on a porcelain crucible lid, or on a glass slide, and heat the residue as long as it continues to evolve *thick* white fumes. Dissolve the cooled residue in a drop or two of NH_3, add a drop of $BaCl_2$, and stir with a glass rod. If urea had been present, a crystalline precipitate of barium cyanurate will be formed on the lines of friction made by the rod upon the glass slide.

A very characteristic test for the cyanuric acid consists in dissolving it in a drop or two of ammonia, and adding a drop of a weak solution of cupric sulphate. On standing for a few minutes, a violet colored crystalline precipitate separates. If the experiment be made on a crucible lid, this precipitates collects in the angle of the lid when the latter rests obliquely on the table, and a very small quantity becomes perceptible. The precipitate appears to be the cyanurate of cuprammonium described by Wöhler, and is seen under the microscope to consist of very definite rhomboidal plates of a fine red-violet color.—*Chem. News.*

PREPARATION OF PHENETOL.

By H. KOLBE.

CRUDE sulph-etheric acid, obtained by quickly mixing equal volumes of concentrated sulphuric acid and strong alcohol, is, when cold, diluted with water, neutralized with soda until it has an alkaline reaction, and the solution is evaporated over an open fire until abundance of sodium sulphate has crystallized out. The warm mother-liquor is mixed with a thick solution of phenol sodium and the whole is heated in an autoclave for some hours to the temperature of 150° under a pressure of 7 atmospheres. The solution of phenol sodium is obtained by mixing the calculated quantity of phenol and soda-lye at sp. gr. 1·33. In calculating the required quantity of phenol and sulph-etheric salt, we proceed on the assumption that half the alcohol employed is recovered as sodium sulph-etherate. On opening the autoclave the phenetol is found floating upon the semi-solid saline mixture. It is drawn off shaken with water, and rectified. In a corresponding manner may be obtained anisol, and doubtless nitranisol and nitrophenetol, by means of nitro-phenol sodium.

HAIR RESTORERS.

THE custom of dyeing the hair so as to change the color bestowed by nature to one more favored by fashion, or to conceal the appearance of white hair indicative of advancing years, is very ancient, and, so far as we can learn, belongs to every country and people, savage or civilized—with this difference: that, while the savage or semi-civilized have to content themselves to a great extent with those juices and extracts of vegetable origin which their limited observation has taught them possess coloring properties, their more favored and cultivated brethren can call in all the aids of science and multiply almost indefinitely their dyeing agents. With the vegetable dyes, such as are derived from plants belonging to the genus *Indigofera* or *Hibiscus*, or others which need not be mentioned, but which have been used in many countries from an early date for dyeing purposes, we do not at present purpose concerning ourselves.

It will be sufficient for one paper if we confine ourselves to the several metallic dyes more generally in use in the present day, keeping in view more particularly their composition, mode of application, and chemical action. It is almost unnecessary to make any preliminary statement regarding the increase in the class of preparations known as hair dyes or restorers of recent years. That this increase has been the effect of any remarkable development of ingenuity in discovering new processes or new agents for the purpose either of dyeing or restoring the hair, notwithstanding that the knowledge of the art of dyeing, and the agents used in the process, have both increased, may well be doubted. More than a dozen years ago there was published in these columns an analysis of ten of the more widely advertised "Hair Restorers," and every one of the ten preparations contained *lead* in one form or another as the active ingredient of the "Restorer." Half a dozen years afterward the *Lancet* revived the investigation, and out of twenty-one preparations, seventeen were found to contain lead. A careful examination of the new preparations introduced since then, together with a perusal of the whole literature of the subject, convinces us that matters are still very much the same. This is the more astonishing, whether we consider the extent to which such preparations are now employed, or the risk attending the repeated use of a lead restorer, or the clearer knowledge in recent times of the principles of the art of dyeing, or the increased facilities for carrying on the operation, or, above all, the capability of the hair beyond most substances of being acted upon by many chemical agents.

Hair, from its very structure and composition, is susceptible to the majority of ordinary dyes used in coloring fabrics as well as to many chemical agents that are not and cannot be applied to such purposes. It is, for example, not only porous, and therefore capable of being acted on by ordinary coloring agents, but it also contains a considerable proportion of sulphur, and is therefore capable of being effectively acted on by a majority of the metallic salts which cannot be considered in the ordinary acceptation of the term coloring agents. It is this last property that has brought the lead restorers so much into use. When a solution of a soluble lead salt such as acetate is applied to the hair, a certain portion of it becomes absorbed, and darkens it in proportion to the amount of sulphur present in the hair; a black sulphide of lead being formed.

Sulphur being always present in light-colored hair in greater abundance than in dark, the conditions are favorable to the maximum effect being produced. Similarly soluble salts of mercury, silver, bismuth, gold, and other metals all produce the same result, the depth of color obtained in each case being dependent upon the strength of the solution and the amount of sulphur present in the hair. A typical preparation of this class, and one which we know at one time had a very large sale as a proprietary article, consisted of two grains each perchloride of mercury and chloride of ammonium to the ounce of perfumed and colored water.

The preparation seemed to answer admirably all the purposes both of a wash and a restorer, and no inconsiderable number of certificates were obtained as to efficacy. We have no wish to puff the preparation, in face of the Poison Act, but we confess we never heard of any more serious result from its use other than the deterioration of various trinkets not sufficiently protected from its influence. This preparation was in use long before Dr. McCall Anderson made his famous discovery of the new "and most perfect black dye for the hair which has been seen," consisting in the use, first, of a solution of perchloride of mercury, and afterward of a solution of hyposulphite of soda.

The hyposulphite of soda in this instance is made to yield sulphur where, from deficiency of the natural product, the bichloride solution does not undergo decomposition sufficient to darken the hair. The decomposition is stated as follows: Hyposulphurous acid being liberated from the soda decomposes into sulphurous acid and sulphur; the sulphurous acid in turn reduces the perchloride of mercury to the mercurous chloride, and the liberated sulphur converts this chloride into sulphide. Theoretically this may be correct enough, but practically any one who has examined the changes which take place on the addition of a solution of perchloride of mercury to a solution of hyposulphite of soda, or *vice versa*, will have found that the conditions determining the changes are much more complicated than appears from the forgoing simple statement. If, for example, a solution of hyposulphite of soda of 2 or 3 grains to the ounce of water be added in equal proportions to a solution of perchloride of mercury of the same strength, a dense yellowish-white cloudiness will at once apppear, changing more or less rapidly, according to exposure, to gray and finally black. If, however, the same strength of solutions be added to each other in the proportions of one part of hyposulphite to two or more parts of perchloride, a pure white precipitate will be formed, more or less dense according to the excess of perchloride solution, and which darkens only slowly, and not to any great extent even on exposure to direct sunshine. On the other hand, if the solutions, still of the same strength, be reversed in the proportions in which they are mixed, that is to say, two or more parts of hyposulphite of solution to one of perchloride, no apparent reaction will take place, the mixed solutions remaining quite clear, though slowly darkening on exposure.

More of the solution in excess added to either of the mixtures does not affect them, but if the smallest crystal of either salt be dropped into the solution a change at once takes place. If a crystal of hyposulphite be dropped into the mixture with the white precipitate caused by excess of perchloride, a dense black precipitate is at once obtained; while if a crystal of perchloride be added to the clear solution in which the hyposulphite is in excess, the dense white and nearly permanent precipitate is quickly formed. Without in the mean time entering into the chemistry of these phenomena, we may point out that they clearly show the conditions necessary to a successful application of this restorer or dye. First, the hyposulphite solution should in strength be in excess of the perchloride solution; second, that the application of the perchloride solution should always precede the hyposulphite; and lastly, that the perchloride solution should be allowed to dry on and into the hair before the application of the second solution, so as to present the salt to the action of the hyposulphite in the form best adapted to produce the maximum results.

It is remarkable that nearly all the "lead" restorers of the present day, as in those analyzed for *The Chemist and Druggist*, as well as for the *Lancet*, are identical in nature. That is to say, they all contain a certain amount of lead in solution with sulphur and sulphate of calcium in suspension. This uniformity of composition either shows a sad want of ingenuity in striking out a new idea in the hair-restorer line or a melancholy example of following the multitude to do evil. We have never been quite able otherwise to account for the reason why the great majority of advertised preparations so faithfully adhere to the sulphur programme.

It must either be added in the belief that it aids the natural product in the hair to effect decomposition of the lead salt, or it is added as a blind to cover the real nature of the mixture. In either case we consider the blunder unpardonable.

Of more scientific character are a few preparations in which the sulphur and lead are both presented in solution in the form of hyposulphite. Hyposulphite of lead is insoluble in water, but it is soluble in excess of hyposulphite of soda, so that if an ordinary solution of acetate or nitrate of lead be taken, and solution of hyposulphite of soda added until the precipitate first formed be dissolved, there is an exact reproduction of this class of restorers.

They are altogether a more elegant class of preparations than the preceding. From absorption of oxygen on exposure to the air they are quickly decomposed into the dark-brown sulphide of lead; and they require special notice in this, that their true nature may not at once be discovered, seeing that they fail to give the characteristic reaction of lead with some of the more common reagents if the hyposulphite is in excess, such as dilute hydrochloric acid and iodide of potassium.

Still another preparation of this class was recently introduced (*Moniteur Scientifique* (3) xii., 880) in the direction of "compounding a metallic tincture that should have an innocuous metal for a basis instead of lead." This, shortly stated, consisted in making an ammoniacal solution of a tartro-bismuthic salt and to this adding about an equal quantity by a weight to the bismuth originally taken of hyposulphite of soda. This forms a colorless solution, which, upon exposure and evaporation, decomposes, depositing a sulphide of bismuth. It is perfectly harmless, but will probably never be very popular, owing to the slowness of its operation and from the fact that, even after long-continued use, it does not deepen the color of the hair beyond a chestnut brown.

Should any one wish to try this restorer they may produce an equally good preparation, with less trouble, by simply making a dilute solution of the Pharmacopœia citrate of bismuth and ammonia solution and adding to it hyposulphite of soda in excess of the bismuth. No reaction takes place on the addition of the hyposulphite, nor will any take place until the mixture is exposed, when, from loss of ammonia and the action of the atmosphere, it slowly deposits the sulphide of bismuth.

It is almost unnecessary to point out here that with solutions of the majority of metallic salts, and with all those already mentioned, an instantaneous and energetic dye may be produced by applying a soluble sulphide—such as sulphide of ammonium or sulphide of potassium—to the hair after it has been sponged with the metallic solution. Two objections militate against this, however—namely, the disagreeable nature of the sulphide solution, and the necessity for the two solutions being sent out in separate bottles.

Silver salts, particularly the nitrate, have been used for a very long time as hair dyes, and are probably the best known and the most effective in producing an action on the hair, and will therefore always command a certain attention, notwithstanding one or two drawbacks to their use—such as staining the skin. A solution of nitrate of silver may be used either plain or with solution of ammonia added in excess, or with a deoxidizing agent, such as pyrogallic acid. When a simple solution of nitrate of silver is exposed to light in presence of any organic matter—such as animal tissues—it enters into combination with them quickly, forming insoluble black compounds. The change is not perfectly understood, but probably a black oxide of silver is produced, with partial reduction of the silver also to the metallic state. Such a solution, it will be understood, can readily be applied to the hair, but it will at once be seen that it will affect not only the hair, but also the skin, as well as every other organic substance in the shape of head-gear coming into contact with it.

This is one serious objection to the use of a simple solution of nitrate of silver. The ammonia solution of nitrate of silver meets the difficulty to a certain extent, but not altogether. It hastens the process of decomposition, and in this way lessens the risk, but it cannot quite prevent the action of the silver on the skin or other substances even where the greatest care is bestowed. When ammonia is added to a solution of nitrate of silver gradually an olive-brown precipitate is formed of the protoxide of silver. This oxide is peculiarly susceptible to change on coming into contact with organic matter, but as it would be of little use in the dry state, and as it is almost insoluble in water, advantage is taken of its solubility in excess of ammonia to prepare a solution, not only, comparatively speaking, stable in itself, but which on exposure to the air and in contact with any organic substance quickly deposits the silver in the condition most susceptible to effect the decomposition necessary.

We have, therefore, in the case of a simple solution of nitrate of silver, the salt slowly decomposing when applied to the hair into the black oxide with reduction of silver to the metallic state. With an ammonio-nitrate solution we have an oxide ready formed and deposited on the hair with more speedy reduction of silver to the metallic state; while with the third method, namely, by using a reducing agent, such as pyrogallic acid, we have the decomposition effected almost at once. This may be illustrated very well by making solutions of each of the three preparations, and exposing a piece of porous paper to their influence in the open air.

In the case of the simple solution the paper will be found to turn, first, slowly brown, and, more slowly still, black; In the case of the ammonio-solution it quickly turns black, while with the last, immediately on adding the pyrogallic acid to the silver solution an intense black is immediately struck. This rapid deoxidation of the silver solution under pyrogallic acid will explain why the two solutions require to be sent out in separate bottles, and forms one of the principal objections to the use of an otherwise serviceable preparation. Various strengths are suggested for all the three different preparations, from 20 to 30 grains of nitrate to the ounce being the more common.

It need scarcely be pointed out that with solutions of this strength the preparations partake more of the nature of quick dyes than slow restorers.

If the order were reversed, and a weak solution, as well as a slower restorer used, as in the case of the lead solutions, a much safer, and in the end an equally efficacious, preparation would be the result. Pyrogallic acid also reducts salts of mercury, gold, and platinum. With mercury salts it does not yield so effective a preparation as the preparations of mercury already referred to as restorers, while the gold and platinum are so expensive as practically to put them out of court. If a chromatic display is desired, the proto and per salts of iron in various proportions, or a mixture of both, may be used with the pyrogallic solution, and various tints of color will be produced, ranging from a beautiful indigo to a deep green.

Pyrogallic acid is not of metallic origin, but from its important chemical relations, as well as from its own individual value as a hair dye, we may well be excused for referring to it for a moment before we conclude. When exposed, for example, in solution to the atmosphere, it rapidly absorbs oxygen, becomes brown, and ultimately deposits a black insoluble coloring matter. The insolubility of this compound is the more important, as when formed in the hair it remains unacted upon either by sweat or moisture. Probably the rapid oxidation of the pyrogallic acid in solution has prevented its more extensive use as a hair restorer, as otherwise it forms one of the best and safest and most permanent dyeing agents to be found, and we cannot account for its general neglect at the present time.

In connection with it we would throw out two hints which may not be generally known, and which may be taken and developed by any one of ordinary enterprise, viz., first, that the addition of a small quantity of *sulphite* of soda to an aqueous solution of pyrogallic acid will preserve it for a very long time unchanged; and, second, that the addition of this preserving agent does not prevent the solution being acted upon and developed into an energetic dye of any degree of shade on the addition of a solution of carbonate of ammonia.—*Chemist and Druggist.*

[KANSAS CITY REVIEW.]

UNCOMMON DISEASES IN PERU AND BOLIVIA.*

By EDWIN R. HEATH, M.D.

"Varruga de Sangre," Verruca hæmorragica (Bloody Wart).—Prescott, in his "Conquest of Peru," mentions a peculiar disease which attacked the Spaniards during their wanderings among the mountains, to which they gave the name "Varrugas," their name for wart, owing to the excrescences of the eruption resembling warts.

In 1871-72, when the Callao, Lima & Oroya (now Trans-Andine) R.R. was in course of construction and had its terminus at the present station of San Bartoleme, thirty-nine miles from Lima, with its camps extending some ten miles beyond, the workmen were attacked by severe and distressing pains throughout their entire bodies. At first, the attending physician supposed them to be rheumatic, but their ceasing as soon as the eruption appeared proved them to be the premonitory symptoms of "Varrugas." The eruption consisted of a fungous, spongy outgrowth from which the blood oozed upon the least touch, and often spontaneously. Their size varied from the size of a pea to two and a half inches long by one in diameter. The roots perforated the derma when external, and the muscular coats when on the mucous membranes. The eye-balls, nasal, buccal, and vaginal cavities not escaping, and post-mortem examinations revealed the mucous and serous coats affected with smaller but similar warts.

There were three varieties, the large, distinct, spongy wart; the confluent, undeveloped eruption, resembling variola, with rounded instead of depressed center; and that fine eruption, as if millet seed were between the derma and epidermis. The two last were occasional after-effects of the first. A patient having the first, upon recovery, might have the second, and, barely better of that, break out with the third, or intervals of from six to twelve months might elapse during which time perfect health was enjoyed. Again, one could have either without the other, although none were ever known to have them in the reverse order, and once having they seem to be protected from a repetition, except in the passage from the first to the third as above mentioned. If the eruptions did not appear, if they appeared internally, or the first variety was very abundant, fatal hemorrhages or paralysis occurred. Except for the pains and annoyance from the loss of blood, one could attend to his daily duties.

A ravine, some six miles beyond San Bartoleme, bears the name Varrugas. The general disinclination of the native Indians to bathing in cold mountain streams, and their statement that the varrugas resulted from baths in the stream of that name, gave that as its origin, which for a time was believed.

The unprecedented magnitude of the work attracted many visitors, most of whom came with fear of the varrugas, and great care was observed not to touch water, either as a beverage or article for cleanliness. Passengers, arriving at 11 A.M. and leaving at 1 P.M., abstaining from food and drink and shunning water as one attacked by hydrophobia, did not insure them against the disease, many breaking out within two months of their visit to the varrugas region, and often these were the worst cases. Others worked there for years, drinking and bathing, with impunity, in all kinds of water.

A few, after they had returned to the United States or Europe, at the end of one and two years were attacked, so that the period of incubation could be said to vary from six weeks to three years.

Three hundred miles north of Lima on the Pacasmayo, Guadalupe & Magdelina R.R., at the station of Chilete, the same disease broke out, but less violently.

Varrugas ravine, on the Trans-Andine R.R., is sixty-three miles from the coast at an elevation of 5,340 feet; Chilete, on the Pacasmayo R.R., is sixty-five miles from the coast at an elevation of 3,700 feet. The breaking up of the earth and rocks, during the construction of the railroads, apparently filled the air with floating germs or mineral poison which entered the system through the lungs, and was then carried to the capillaries, where it took root and was nourished by the blood, or caused an unusual growth to wash out the poison. As yet the point is unsettled, although all discard the water theory. After the roads were finished and the ground settled, the disease disappeared.

At the time the varrugas disease was at its height, a fever resembling sporadic yellow fever broke out on the Trans-Andine R.R., and by many was considered as one with the varrugas. Dr. Logan, ex minister to Chili, while in Chicago, wrote a work on the diseases of the west coast and had classed them as Varrugas or Oroya fever. Happening to call on him at this time, the author being in the transition stage between the first and the second varieties, and having no fever nor having had any, proved that the diseases were two and distinct.

"Mal de Siete Dias" (Seven Days' Sickness).—On the coast of Peru, as far south as the 12th parallel of latitude, anger will so change the milk of a mother that it will cause the death of a child within seven days. Should a mother wish to free herself from the labor of raising her child, she lets herself get angry, puts the child to her breast, and the end is sure. It is an every-day occurrence for a mother to send a child to a neighbor requesting that it be nursed, saying she had been angered by her servants, or children, or some one. In an hour or two the effect passes off and the milk comes good, even though left in the breast and a deadly poison but a short time previous.

"Aire" (Air).—By this is understood a change of air that acts perniciously upon the human system, either in perfect health or debilitated by sickness. In the hospital of the Pacasmayo R.R., where from 100 to 180 sick and wounded were cared for, all would be doing well, wounds granulating and painless, convalescents happy in the thought that but a day or two more and they could go to their work. Suddenly, with no change of barometer, or thermometer, or electric tests, the wounds would turn black, gangrenous, and painful, and the wards, so silent five minutes before, would be filled with groans, vomitings, and fevers. This would last for three days, and then go as it came. At these times one would have the muscles of one side of the face contracted or the head drawn on one side or the body bent back or to one side. The least exposure in a draught at any time would be liable to cause these same effects, but at these times more readily. Often cooks and nurses were made ill, so that no one was free. Six years of careful observation failed to detect the cause. Chemical tests were made, the microscope used faithfully, thermometers, barometers, and magnetic machines watched. The ocean's temperature and currents, as also the air's temperature, currents, force, direction, and weight noted four times a day, and we are free to confess we acknowledge the fact, but why we never could detect.

In Peru, the climate being such that many sleep out doors, gives opportunity for an occurrence like the following, which causes several deaths among children each year. There exists a snake of the boa-constrictor species which lives upon vermin and which is protected by the owners of estates for their utility. They, however, are very fond of milk, and at night quickly find where the nursing mothers sleep. Noiselessly approaching they coil themselves beside the mother, and while they rob the child of its nourishment, they keep it quiet by inserting the point of their tail in its mouth, and thus the child wastes away from insufficient nourishment. The author of this was inclined to scoff at the story, but assured of its truth by such men as Dr. A. Arrigoni and Prof. Raimondi, we had to accept it, and give it, believing it to be true.

Ring Worms (Herpes circinatus).—On the river Madeira, in Brazil, nearly all the workmen on the Madeira and Mamore R.R. were attacked with ring worms; some lightly, others over the entire body.

Goitre, "Puperas" (Gotto).—Arriving at the towns on the plains of northeastern Bolivia, we were surprised to find so many cases of goitre. At least ten per cent. of each village had either single or double goitre, the females exceeding the males in proportion of six to one. Both children and grown people, Indian, negro, or white, all were affected. In a town near Santa Cruz de la Sierra, ninety-nine one-hundredths have it, and some assert that it even attacks animals. As these people live on low lands, far from mountains and snow, many never using water that did not come from wells fed by the rains, it must be acknowledged that the theory of the "snow water cause" must be discarded. Besides, those who live at the base of the mountains and who might be considered as using water that had once been ice and snow, are entirely free or probably in proportion of one in twenty thousand. These facts, so at variance with the acknowledged belief that in other places holds good, makes it a subject of interest worth more than a hasty thought. The region drained by the Yacuma River lies between two watersheds which run nearly parallel, at that point separated by 200 miles. This region is a low prairie grazing land, and all the water that feeds the river comes from the winter rains and the most ardent supporter of the snow theory must grant that his theory is at fault. At no time in the life of the female can one say it abounds more than at another, as in some parts. Could the winds bring it from the mountains? The winds come from an opposite direction.

"Espundia" (Malignant Indolent Ulcer).—In the Department of Caupolican, in Bolivia, there are some cities of consideration, among which is that of Apolobamba. The pasture lands about that city are insufficient to supply all the cattle needed for beef, hence they are very dear. On the plains of the Department of Beni cattle are abundant and cheap. As a natural consequence there exists a traffic in cattle between those two Departments. The droves pass the River Beni at Rurenabaque in S. lat. 14° 26' 21", thence along the base of the mountains northwest to Tumupasa, then turning west, cross the intervening ridge, descending to the river Tuichi at San Jose, cross it then by dangerous and difficult mountain paths to "Apolo." This latter part must be passed on foot, as no horse or mule can travel there loaded. It is during this passage on foot that the traveler is exposed to the espundia. At first it appears as a small pimple, generally upon the lower extremities, between the knee and foot. This pimple grows rapidly, and is painless. Soon the top decays and drops out, leaving a cavity with raw, red, irregular, ragged edges. When the ulcer, if on the lower extremities, has spread to two inches in diameter, its further growth is very slow. Many times it breaks out in the nose, and then the ulcers on the other parts heal. From the nose, it spreads all over the antra, sinuses, mouth, throat, and in places on the face, eyes, and ears. The ichorous discharge from the nose and throat is fetid; that from the external ulcers less so. Actual cautery with a red-hot iron will kill it in the start, but excision only hastens the formation of an ulcer.

Many fatal cases occur, but the majority heal in five or six years.

Opinions differ as to the cause. Some assure you it is a sting of an insect, some of a nettle, while others claim it to be a mineral poison which passes into the circulation through some abrasion.

The actual cautery by arsenic followed by internal minute doses will cure seventy-five per cent.

Grubs of the Oestrus Fly.—One of the unpleasant annoyances of a life in the forests about the Amazon and its tributaries is the deposit in the body of eggs by the Oestrus fly. These eggs soon hatch out worms which grow to one-quarter of an inch in diameter and three-quarters to one inch in length. We have seen birds with their bodies full of these worms. Their usual place of deposit on the human being is the nape of the neck. But this is trifling beside the itching produced by the bites of a minute insect, the "Acarus Scarlata." Wherever there is grass or pasture lands in these low, damp countries this insect is found, but more abundant in the dry season. As soon as it is filled with blood it can be seen as a red speck at the root of the hairs of the body, in the folds of the navel and nipples. During the month of its greater abundance none escape without scratching themselves raw, often forming distressing sores. One learns to shun the grass. The public squares and spaces about the houses are carefully kept free from it. Nor are the forests free from pests. One of the duties of a hunter in the Amazon forests is occasionally to strip off all clothing and pick off the small woodticks before they burrow under the skin. Once they make an entrance they must not be pulled off, as it will sever the body from the head, and this is a poison to be avoided. The usual way is to place a lighted cigar or ember near their bodies, and the heat causes them to withdraw.

These are not diseases in themselves, but the after effects often prove very difficult to treat successfully.

* In submitting to your readers the accompanying article I have avoided as much as possible technical names and theories. As a traveler, the facts which might be useful to know are sought after and simply recorded.

Published in a medical journal, this article would need to have been more explicit, and then it would only have reached a certain class of readers.

Only striking specialties have been noticed, yet much might be written on the diseases of those countries which might be useful as determining the geographical distribution of disease. For instance, in the mountains of Bolivia, especially on the eastern slopes, cataracts and opaque corneas are very common, not differing from other places except in their abundance. This subject alone, presented in all its merits, would be valuable to scientists, but this not being a treatment of the geographical distribution, it and many other similar facts are not touched on.

PEPTONE IN THE GASTRIC MUCOUS MEMBRANE.

By F. HOFMEISTER.

DURING the act of digestion, the stomach of the dog is opened along the smaller curvature, spread out, and then divided by a suture carried from the pylorus to the cardiac end into two halves as nearly as possible symmetrical. It might be anticipated that when the viscus was carefully freed from adhering contents, both portions would yield equal proportions of peptone. This, however, is true only when both are simultaneously immersed in boiling water. Should one be left undisturbed for a time, its peptone will be found to diminish in a remarkable manner, and even wholly disappear.

This disappearance of peptone is a vital act, taking place, according to the stage of digestion, with unequal rapidity, and arrested by heating for a few minutes to 60° C. If the stomach, previously extracted and wiped dry, be placed in the moist chamber for one or two hours at 40°, the mucous membrane is further observed to secrete a fresh layer of mucus, and the muscular contraction to restore the stomach to its original condition.

Since the transformation of peptone also takes place in the stomach of bled animals, it follows that the blood has no share in the result. The cause is to be sought for in chemical changes which have their seat in the gastric mucous membrane. An explanation is thus afforded of Salvioli's experiments (*Archiv f. Physiol., von Du Bois Reymond*, 1880, Supplement Band 112), in which it was observed that peptone introduced into the intestine disappeared in a few hours without being detected in the efferent venous blood, while no such disappearance took place when blood injected with peptone circulated through the intestinal vessels. It also proves that the property of assimilating peptone belongs not merely to the stomach, but is a common characteristic of the intestinal mucous membrane.

Whether this assimilation is accompanied by a reformation of albumin or by a complete disintegration, or in what part of the mucous layer it takes place, whether in the epithelial cells of the glandular portion, or the lymph cells of the adenoid tissue, has not yet been determined. But to this the author hopes shortly to proceed.—*Zeitschr. Physiol. Chem.*

POLLUTION OF THE WELLS OF MILL COTTAGES.

THE erection of a mill or factory in the country involves also the construction of cottages for the workpeople. The best location, size, plan, and surroundings of these humble domiciles are often more difficult to determine than the proper proportions, material, and machinery of the stately mill.

Although proximity is always desirable, yet location will be more or less dependent on the contour of the surface and the direction of existing roads and intercourses. The aspect will also be governed by the lay of the land, for while, despite the difference of climate, a southeasterly exposure is perferred both in England and America, yet that the surface drainage should be from the front to the rear is important, however the compass may point.

The size should be small, but not uniformly so, for families will vary in numbers, and each head should be encouraged to have a house to himself. From two rooms, one over the other, and a lean-to kitchen, three rooms in all, to four rooms, two below stairs and two over them, with a lean-to kitchen, five rooms in all, would be large enough to accommodate the variously sized families, especially if a garret over the two-storied part be added. A cellar under that part only would suffice, none being needed under the kitchen.

The plan of building cottages, two together, with space between each two, is conducive to health and cleanliness. The "twins" need not be more than 15 feet apart; the door of entrance to each cottage, being on the side, between the front and back room, with the stairway straight from a small vestibule. Access to every room will be easy and direct, and the space frequently taken up by a front hall or entry saved.

If a small lot be left in front of the cottages it should be inclosed with a cheap picket fence, and the remainder of the ground of each with a tight board fence. By the judicious distribution annually of a few flower seeds and roots encouragement may be given to the conversion of the front lots into gardens, and the row of cottages thus become "a thing of beauty and joy" to the owner as well as to the tenants. More important is it to have the lots deep at the rear to encourage therein the production of vegetables for the table. In these, the diet of the workingman is too often scanty. Of their health-giving properties he knows but little, and he becomes a prey to disease, which one of their functions is to avert. Still more important is it that the drinking water drawn from the wells should be free from taint. Disgusting as the statement may be, it is nevertheless

true that from carelessly putting the privy well or cesspool and the well for the pump both in the rear of the cottage, underground communication sometimes exists between them. The means of communication need not be sufficient to admit of the passage of solid matter or even of liquid matters absorbed from the cesspool. Gases, evolved by decaying excrement or garbage, may, by entering the pump well above the water line, become dissolved by the water, and thus prove a prolific source of disease. The distance which the gases, without losing their polluting power, may travel through the ground depends upon its nature, and cannot be definitely determined.

If it be composed of porous materials, or of several strata, themselves perhaps impervious, but the interspaces at their surfaces of contact not gas tight, then sources of pollution may be transmitted. The nature of the subsoil and the subjacent strata may sometimes be learned by observing them while the cellar or the first well is being dug. Not unfrequently the digging of a pump well is preliminary to the building operations proper, and the opportunity it sometimes affords of acquiring a knowledge of the strata should not be lost. The dictate of prudence is to put the two kinds of wells as far from each other as the convenience of the tenant will permit. A company which, from the roughness of the surface adjacent to its works, was unable to find sufficient level ground for rows of cottages in pairs, built them closely together. The pump wells were dug in the gardens in front of the cottages, the other wells in the rear. The arrangement is such that the two adjoining dwellings, using the same pump, do not use the same cesspool, and *vice versa*. By digging the two descriptions of wells not in line, but diagonally from each other, the distance between them is increased without extending the ways of access to them from the cottages. In the twin cottage system the pump is placed in the line fence between the two adjoining side yards, and is therefore readily accessible from the side doors of entrance, while the cesspool is dug in the rear on the line of fence between the two cottages which form a pair, and is reached from the back door.

One method of preventing communication is to line the walls and bottom of the cesspool with hydraulic cement. The bottom must be first well rammed and dressed with a covering of small stone, as the least yielding would crack the cement. Through the narrowest cracks, whether in the bottom or on the sides, streams of pollution, liquid or aeriform, may pass. Asphalt answers perfectly, but as it must be applied hot, the interior surface must be first dried by kindling a fire, and maintaining it until the moisture is evaporated to a sufficient depth to prevent contact with the heated asphalt when laid on.—*Textile Record.*

ALGIN: A NEW SUBSTANCE OBTAINED FROM SOME OF THE COMMONER SPECIES OF MARINE ALGÆ.*

By E. C. C. STANFORD, F.C.S.

THE utilization of hitherto waste materials presents a large field for chemical investigation, and many important industries have within the last twenty years resulted from such researches.

There are few materials so abundant, so general, and so easily obtained as the commoner kinds of seaweed thrown up on all our coasts, but especially on those exposed to the waves and storms of the Atlantic. The species I refer to—the laminaria and fuci—are found growing on all rocky shores. And it may also be remarked that, except as manure, the great bulk of this material has been long practically unutilized. It is true that, when burnt into the rough slag known as kelp, this material was formerly the means of securing large revenues to the proprietors of the Western Islands. For several well known reasons, that manufacture has long ceased to be profitable, and it never could have been considered as utilizing the seaweed, except in the sense that burning down a forest could be called utilizing it, when it ought to be cut into timber and really utilized in building houses or making furniture.

In 1862, the writer introduced a method of carbonizing the seaweed in retorts, and thus converting the material into charcoal instead of kelp, and preventing the great loss of iodine arising from open air burning. This was simply another step of improvement, and, comparing it again with the forest, was merely equal to making the timber into charcoal instead of burning it into ash. It is not, in a proper and fuller sense, utilizing the seaweed. The results of further attempts in this direction form the subject of this paper. When we remark that the present widespread destitution and want of employment among the poor cotters is most severe in just those districts in Ireland and the Highlands where this material is most abundant, the importance of this inquiry will be at once seen. Indeed, if a remunerative price can be paid for a waste material that every child in a large family can easily assist in collecting at their own doors, it would go far to settle many existing difficulties, of which the worst is always hunger. And this brings me to mention the value of the algæ as a food material. In my paper, read before the Society of Arts, in 1862, on "The Economic Applications of Seaweed," the various kinds so used were described, and I have called attention more recently, in a paper read before the Chemical Society, to the fact that the analysis of the charcoal obtained from the various algæ approximates more nearly to that of a product of the animal than of the vegetable kingdom. I believe the algæ, generally, to be quite as valuable food products as the fungi, with the advantage that we are unaware of any poisonous species. Both are, however, equally neglected in this country. As the edible fungi are much consumed by other European nations, so the edible algæ are largely enjoyed and realize a high price in China and Japan. A sample of one of the Japanese varieties before us yielded on analysis a composition closely similar to our laminaria. It has, however, evidently been cut up, and presents the appearance of long shreds, and is colored green by the action of an alkali. The poor people in Donegal are now eating the *Fucus vesiculosus* with Indian meal, and it is a common thing to see the Highland cattle browsing on this plant at low tide. The *Alaria esculenta*, or murlins, of which a fine specimen is on the table, may be called our edible species, but the *Rhodomenia palmata*, or dulse, is perhaps better known in Glasgow, being regularly sold on the streets.

The most important species consumed in this country is the *Chondrus crispus*, or Irish moss. This plant contains 79 per cent. of carageenin, a substance of great gelatinizing power, and largely used in jellies and puddings. This seaweed would, no doubt, secure a considerable market as a size for fabrics, but it cannot be obtained in any great quantity. It is only uncovered at low spring tides, and any very large demand would soon exhaust the supplies. A recent application of Irish moss is being worked by a limited company, under the name of "velo-plastic," which is said to be made of refuse leather, dried and finely ground and mixed with carageenin. I am indebted to Mr. John A. Walker, of Dublin, for specimens of green and yellow morocco, poplin, and satin damask, and watered silk, all of which appear to be most successful imitations. The new substance to be described in this paper would probably answer equally well for this application.

Another still more powerful gelatinizing substance is gelose. This was first imported into France from China in 1856. It has ten times the gelatinizing power of isinglass, and will set into a jelly five hundred times its weight of water. It is not nitrogenous, and contains carbon, 42·8; hydrogen, 5·8; oxygen, 51·4. It has not superseded isinglass for jellies, as the fusing point of the jelly is too high to melt in the mouth. I found some years ago, in experiments on every variety of seaweed that could be procured, that this gelatinizing principle was confined to two British species—the *Chrondrus crispus* and the *Gelideum corneum*. An Australian alga, the *Euchemia spinosa*, or agar agar, is also a jelly-yielding species. Several articles have recently been introduced under various names, such as thao, fucyne, etc., all of which appear to be modifications of, or products from, these plants.

The application of seaweed as manure is very general where it can be obtained. In fact, the practical value placed on it is far above its actual chemical valuation. It usually contains 80 per cent. of water, so that four tons of water are cartered to the land for every ton of dry seaweed, and even when dried there is not a large saving in carriage, as it is then very bulky. It is, however, carried long distances in some places, and there is no doubt that it is very valuable on soils that are all sand; but it is more of a mechanical value, as its use is not to *manure* but to *make* the soil—a rather expensive manufacture. Kelp waste, a ton of which, dry, represents forty tons of wet seaweed, and contains all the phosphates of the weed in a convenient form, is absolutely unsalable to farmers in this country at any price.

The only other important proposed application of seaweed has been to the manufacture of paper, and about twenty years ago several patents were taken out with this object, and some specimens were exhibited at the Society of Arts on the occasion before referred to. They were all made, however, from the *Zostera marina*, or grass wrack—a marine plant with flowers growing in the sea, but not one of the algæ—and this plant makes a very good paper. It created a good deal of attention at that time, having been proposed as a substitute for cotton during the cotton famine. It is not, however, available in large quantity, and contains very little fiber. The algæ generally contain no fiber, but, as far as my experiments have gone, nearly every species yields a very pure cellulose, which makes a tough, rather transparent paper. The tissue of the plant consists of simple cells of various shapes laid end to end, and in the fuci containing a dark pigment. This cellulose fabric, which forms the paper material, amounts, when quite dry, to 10 per cent. of the air dry plant. In working on the fuci and the laminariæ my attempts to make a paper pulp were much impeded by a peculiar substance common to both these species, which was found at first difficult to remove, and the presence of which rendered the paper brittle. In fact, this appeared to be always the case unless the cellulose was obtained quite pure. This substance is present in large quantity, and forms the bulk of the plant after the salts are removed.

Any one observing the long flat fronds of the laminaria lying on the sea shore must have noticed two things. 1st, that these are easily bleached by exposure to light; 2d, that, after exposure to rain, the fronds contain in their interior sacs of fluid. These are derived from the endosmosis of the water through the outside membranes, dissolving a peculiar glutinous principle. Upon opening one of these sacs, a neutral glairy, almost colorless, liquid escapes. Sometimes it may be seen partially evaporated on the surface of the frond as a jelly-like substance, which may be drawn out by the fingers in long, tenacious strings. This fluid contains a unique substance of remarkable properties, and to which, from its source, I have given the name of algin. The vesicles are only seen in the long fronds of the various laminaria, especially *L. stenophylla*, known in the Highlands as bar-darrig, or red-top. The large stems or tangle, and the fuci, although containing it in considerable quantity, do not exhibit this appearance.

If the liquid be evaporated to dryness, the scales so produced resemble albumen, and are not all soluble in water, but very soluble on the addition of a little alkali. Several other instances of the solubility of substances when endosmozed or dialyzed are well known. The fluid thus naturally obtained is miscible with water, but coagulated by alcohol and by mineral acids. It cannot be obtained in sufficient quantity for exhaustive analysis, but it contains calcium, magnesium, and sodium, in small quantity, in combination with algin. If the laminaria fronds are cut up and macerated in dilute hydrochloric acid, the liquid in the vesicles assumes the form of a colorless, insoluble jelly. If the laminaria fronds are immersed in water containing a little alkali—by preference sodium carbonate—the whole plant becomes disintegrated, and presents a gelatinous mass, consisting of a thick, glutinous, gummy liquid, containing the cellular fabric of the plant completely broken up. This occurs in twenty-four hours in the cold. The mass, although it only contains 2 per cent. of the algin, is so glutinous that it cannot be poured out of the bottle. It is very difficult to deal with, on account of its extraordinary thickness. In fact, as it is, no method of filtration is possible (all known methods, with and without pressure, have been tried). The cells to be removed are so minute that, if pressure be applied, the whole mass passes through any filter or not at all. By cautiously heating the mass it can, however, be filtered. The medium employed is a coarse linen sacking in the form of a Taylor filter. The cellulose is left behind as a gelatinous mass, amounting, when dry, to about 10 per cent. of the air-dried plant.

The algin solution is then evaporated in a somewhat similar manner to gelatin, and, when dry, presents an appearance which is not unlike gum-tragacanth; but it may also be obtained in thin, transparent, flexible sheets. The solution is slightly alkaline; but care must be taken that no great excess of sodium carbonate is present, or the solution decomposes, and in a week, if dilute, becomes quite thin, and contains no algin. This action of the alkali I cannot yet clearly explain. The solution can be neutralized by the careful addition of hydrochloric acid without gelatinizing; but an excess at once precipitates it. A solution of only 2 per cent. becomes semi-solid, treated in this way. The following reactions are obtained with various reagents. For some of these the solution must be carefully neutralized with acetic acid, which does not gelatinize it.

Dilute hydrochloric, nitric, sulphuric, sulphurous, phosphoric, and mineral acids generally, coagulate it. Boracic acid has no effect.

Lime water, baryta water, and salts of calcium, barium, and strontium, give white precipitates.

Salts of magnesium do not affect it. Acetic, formic, citric, tartaric, and benzoic acids do not affect it.

It is precipitated by alcohol.

Perchloride of iron gives a dark brown coagulum.

Salts of copper, zinc, aluminum, tin, antimony, cobalt, and nickel all precipitate it.

Protonitrate of mercury forms a white precipitate, but bichloride of mercury and silver nitrate have no effect.

Acetate and subacetate of lead both give white precipitates.

Potassium silicate and bichromate, sodium biborate,* and potassium ferrocyanide, permanganate, sodium tungstate, stannate, and succinate do not affect it. No precipitate is produced by tannin.

Concentrated sulphuric acid dissolves it; concentrated nitric acid converts it into oxidation products, among which are oxalic acid.

It is distinguished from albumen by not coagulating on heating, and by not precipitating silver nitrate; from gelose by not gelatinizing on cooling, and by containing nitrogen, which gelose does not; and being soluble in cold, weak, alkaline solutions, which gelose is not; and being insoluble in boiling water, in which gelose is soluble. The laminaria has been boiled in water for a month without effecting any solution, and for a week under forty pounds pressure with a similar result.

It is distinguished from gelatine by not giving any reaction with tannin from starch; by giving no reaction with iodine from dextrine; gum arabic, gum tragacanth, and pectin by its insolubility in dilute alcohol and in dilute mineral acids.

I notice as particularly remarkable that it should precipitate all the salts of the alkaline earths except those of magnesium, and most of the metals except silver and mercury, and with regard to the latter that it should precipitate the protonitrate but not the bichloride; and that it gives no precipitate with potassium silicate.

The gelatinous precipitate produced by a mineral acid represents the algin in its pure, insoluble form. It dries up to a hard, horny substance. A specimen can scarcely be distinguished from horn. I have not yet succeeded in getting it pure and definite enough to be certain of its composition; but I am indebted to Prof. Ferguson for a combustion of the soda compound. This had been carefully dialyzed to avoid the presence of excess of alkali, and gave the following numbers:

Carbon	35·65
Hydrogen	4·40
Nitrogen	3·08
Oxygen	37·23
Ash	19·69
	100·00

This gives the following composition for the algin. I have appended also that of gelatin, isinglass, gelose, and chitin. In nitrogen it is intermediate between gelose and gelatin, but it approaches nearer to chitin than any other substance. Fremy, however, denies the presence of nitrogen in this substance. It differs entirely from algin in being insoluble in alkalies.

	Algin.	Gelatin.	Isinglass.	Gelose.	Chitin.
Carbon	44·39	50·0	50·1	42·77	46·64
Hydrogen	5·47	6·5	6·6	5·77	6·60
Nitrogen	3·77	17·5	18·3	....	6·56
Oxygen	46·37	26·0	25·0	51·46	40·20
	100·00	100·0	100·0	100.00	100·00

(Sulphur, 0·12.)

The percentage of ash in the soda compound does not materially vary. The two following were made—one with sodium hydrate, and the other with sodium carbonate—and yielded almost the same amount of ash:

Sodium hydrate—percentage of ash	31·51
Sodium carbonate, do.	31·37
Mean	31·44

Although I believe the composition to be stated correctly, I cannot construct a formula from these figures; and all attempts to procure definite compounds for analysis have as yet been unsuccessful. The following compounds have been prepared and investigated with this view: Compounds with calcium, aluminum, barium, and lead—but the results have not been uniform enough to show that we have been examining definite compounds.

The sodium carbonate appears to be unaltered in the compound, but completely masked. The carbonic acid comes off only when acidified with an excess of hydrochloric acid, and heated.

The acid has also some decomposing effect, and produces a small quantity of a substance which precipitates Fehling's solution, but does not appear to be glucose.

A solution, 1000 grs. measure, containing 13·2 grs. of algin, was precipitated by standard sulphuric acid, and redissolved by standard sodium hydrate, six times in succession.

1st precipitation took of sulphuric acid (SO_3), grains	5·430
2d " " "	4·070
3d " " "	3·086
4th " " "	1·975
5th " " "	0·617
6th " " "	0·617
1st resolution took of soda (Na_2O), grains	3·778
2d " " "	2.871
3d " " "	2.052
4th " " "	1·530
5th " " "	0·670
6th " " "	0·478

As the precipitate is not soluble in sodium sulphate, there appears to be some decomposition continually going on, and this has not yet been sufficiently investigated to enable me to ascertain the exact action of the hydrochloric acid.

* Read before the Chemical Section of the Glasgow Philosophical Society, April 2, 1883.

* It can be extracted by a solution of borax.

The process proposed to deal with the seaweed is first of all to wash out the salts by simple maceration in cold water. This is very easily done, the salts being almost entirely removed, even by two macerations. On account of the bulk of the material, it is, however, advisable to wash a number of vats exhaustively in turns, in the usual manner of lixiviation common in alkali works. The water removes about a third of the weight of the seaweed, and when evaporated to dryness presents a treacly mass containing the salts and a considerable quantity of a saccharine matter which represents mannite, but which precipitates Fehling's solution equal to fifteen per cent. of glucose. It is, however, unfermentable, and I have not yet succeeded in getting it pure enough for analysis, on account of the great difficulty of separating it from the alkaline chlorides which are soluble in alcohol. By the use of sulphate of silver I have separated a small quantity, but still not sufficiently pure. If this can be separated commercially, and is a sugar having sweetness but unfermentable, it would be available for replacing glycerine in some of its applications. Until, however, more is known of its properties it must be sacrificed by carbonizing the salts; the charcoal, of which it yields about fifty per cent., being then treated in the usual manner for separating the iodine and salts. The salts vary from thirty-five to fifty-five per cent. of the whole; or twelve to eighteen per cent. of the original air-dry weed in the laminaria. This is more than is obtained by burning the weed into ash, which does not, as a rule, yield more than ten per cent. of salts on the air-dried weed.

It is interesting to notice the way in which the salts come out, and analyses have been made with this view. The results are shown in the following tables. Calcium sulphate and magnesium chloride are both present in the aqueous solution of the laminaria and in the residue of the fuci—carbonates generally in the salts of the fuci and the residue of the laminaria. In the latter, which is always submerged, the relation of the magnesium to the calcium is singularly like that existing in sea water.

Within certain limits the composition of the salts differs considerably, the age of the plant and the time of gathering both affecting it.

The following samples are from a considerable bulk of mixed salts evaporated:

ANALYSES OF THE SALTS.

	Laminaria stenophylla.	Fucus vesiculosus.
Calcium sulphate	1·69	4·33
Potassium sulphate	11·29	23·62
Potassium chloride	19 90	13·71
Sodium chloride	60·96	58·20
Magnesium chloride	4·35	....
Sodium carbonate	0·53	....
Sodium iodide	1·26	0·12
	99·98	99·98

In the following tables the composition of the salts are shown as they come out in six successive macerations in cold water.

The residues are always carbonized, and then washed and again ignited—that being the only way to insure perfect combustion in the presence of such an excess of saline constituents.

Laminaria stenophylla—Air-dried.

Containing 14·8 moisture.

4 ozs.=1,750 grains. Six macerations in cold water; all evaporated, and residues weighed.

	Grs.	P. c.	Grs.	P. c.
1st water-weight of residue....	288	16·45	499	=28·5
2d " "	211	12·05		
3d " "	40	2·28	77·2	= 4·4
4th " "	37·2	2·12		
5th " "	21·1	1·20	39·7	= 2·26
6th " "	18 6	1·06		
	615·9=35·16 per cent.			

	1.	2.	3.	4.	5.	6.
Volatile matter..	23·4	28·0	29·3	40·0	54·5	69·1
Salts..........	67 1	60·1	55·5	40·0	31·8	22·5
Fixed carbon....	3·91	4 97	4·1	4·56	2·23	0·96
Ash............	5·59	6 93	11·1	15·44	11·4	7·44
	100·00	100·00	100·0	100·00	100·00	100·00

Composition of Salts.

	1.	2.	3.	4.	5.	6.
Calcium sulph.	2·91	1·02	Nil.	Nil.	Nil.	Nil.
Potass. sulph..	7·53	10·08	19·48	20 80	trace.	trace.
Potass. chlor...	34 05	30·95	24·81	23 78	"	"
Sodium chlor	45 55	53·00	53·57	51·04	"	"
Sodium iodide.	1·95	1·58	2·00	1·25	"	"
Sodium carb...	Nil.	Nil.	trace.	3·30	"	"
Magnes. chlor..	8·55	3·40	trace.	trace.	"	"
	100·54	100·03	99·86	100·17	"	"

Laminaria stenophylla—Air-dried.

Calculated percentage on original weed.

	Per cent.	Volatile.	Salts.	Carbon.	Ash.
1st water........	16·45	3·85	11·04	0·64	0 92
2d "	12 05	3·35	7·26	0·60	0·84
3d "	2·28	0·68	1·26	0 09	0 25
4th "	2·12	0·86	0·85	0·09	0·32
5th "	1·20	0·656	0·38	0·027	0·137
6th "	1·06	0·732	0·24	0·010	0·078
	35·16	10 128	21·03	1·457	2·545

Composition of Salts.

	1.	2.	3.	4.	5.	6.	Total.
Calcium sulph.	0·321	0·074	Nil.	Nil.	Nil.	Nil.	0·395
Potass. sulph..	0·831	0·731	0·245	0·177	trace	trace	1·984
Potass. chlor..	3·759	2·247	0·312	0·202	"	"	6·520
Sodium chlor..	4·970	3 846	0·678	0·432	"	"	9·926
Sodium iodide.	0·215	0·115	0·025	0·011	"	"	0·366
Sodium carb..	Nil.	Nil.	trace	0·028	"	"	0·028
Magnes. chlor.	0·944	0·247	trace	trace	"	"	1·191
	11·040	7·260	1 260	0·850	0 38	0·24	21·030

Laminaria stenophylla—Air-dried.

Residual weed—Weight 2 ozs., or 50 per cent.

		Calculated on original weed, per cent.
Volatile matter	74·2	37·1
Charcoal	25·8	12·9
	100·0	50·1

Charcoal.

Salts	18·0	2·32
Fixed carbon	50·7	6 55
Ash	31·3	4·03
	100·0	12·90

Salts.

Potassium sulphate	35·27	0·818
Potassium chloride	6·72	0·156
Potassium carbonate	5·00	0·116
Sodium carbonate	49 97	1·169
Sodium iodide	2·63	0·161
Alkaline earths	Nil.	Nil.
	99·49	2·320

Fucus vesiculosus—Dried.

Containing 2·11 per cent. moisture.

4 ozs.=1,750 grs. Six macerations in cold water—all evaporated, and residues weighed.

	Grs.		Per cent.	
1st water-weight of residue,	174·5		= 9·45	11·90
2d " "	43 0		= 2·45	
3d " "	11·2	0·64	= 0·99	
4th " "	6·15	0·35		
5th " "	trace			
6th " "	trace			
	234·85		=12·89	

	1.	2.	3.	4.
Volatile matter, etc......	37·78	68·4	47·48	62·86
Salts	49·03	27·62	29·22	25·71
Fixed carbon	8·09	1·17	3·78	0·74
Ash	5 10	2·81	19·52	10·69
	100 00	100·00	100·00	100 00

Salts.

	1.	2.	3.	4.
Potassium sulphate	27·25	48·19	trace	trace
Sodium sulphate	4·03	0·57	"	"
Sodium chloride	61 50	37·62	"	"
Sodium iodide	0·026	0·02	"	"
Sodium carbonate	7·42	13·36	"	"
	100·226	99·76	"	"

*Fucus vesiculosus—Dried.**

Calculated on original weed.

	Per cent.	Volatile.	Salts.	Carbon.	Ash.
1st water........	9·45	3·58	4·63	0·76	0·48
2d "	2·45	1·68	0·67	0 03	0·07
3d "	0·64	0·304	0·187	0·024	0·125
4th "	0·35	0·221	0·089	0·003	0 037
5th, trace........	....	....	....	....	...
6th, trace........	....	....	....	....	....
	12·890	5·785	5·576	0·817	0·712

Composition of Salts.

	1.	2.	3	4.	Total.
Potass. sulphate.....	1·263	0·343	trace	trace	1·605
Sodium sulphate ..	0·186	0·004	"	"	0·190
Sodium chloride ...	2 8378	0·2337	"	"	3·0715
Sodium iodide......	0·0012	0·00013	"	"	0·00133
Sodium carbonate...	0·343	0·0895	"	"	0·4325
	4·630	0·0700	0·187	0·089	5·576

Residual Weed—Fucus vesiculosus.

Weight, 3 ozs. 175 grains = 85 per cent.

		Calculated on original weed.
Volatile matter	65·65	55·81
Charcoal	34·35	29·19
	100.00	85·00

Charcoal.

Salts	18·63	5·24
Fixed carbon	58·53	17·53
Ash	22·84	6·42
	100·00	29·19

Salts.

Potassium sulphate	29·41	1·5420
Sodium sulphate	47·58	2·5030
Calcium sulphate	9·34	0·4760
Magnesium sulphate	11·76	0·6160
Magnesium chloride	1·30	0·0680
Sodium carbonate	0·45	0·0235
Sodium iodide	0·22	0·0115
	100 00	5·2400

After the salts have been removed, the weed is bleached by a weak solution of chlorinated lime, about 2° Tw. The laminaria bleaches easily in a few hours, but the fuci require prolonged and repeated treatment. I will call attention to the extreme beauty of some of the algæ before you when thus bleached, even in the common *Fucous vesiculosus*, or black wrack; you can trace the pores in the cells and lining of the air vessels. The specimen of *Sargassum bocciferum* (gulf weed) is beautifully transparent. Other specimens shown are *Laminaria digitata*, stems and fronds, the former looking like sticks of ivory, *L. stenophylla*, *Fucus nodosus*, *F. serratus*, *Aliaria esculenta*, *Halidrys siliquosa*, *Rhodomenia palmata*, *Rhodomela pinnastroides*, *Zostera marina*, *Enteromorpha compressa*, etc. When sufficiently white, the weed is soured by a very weak solution of sulphuric or hydrochloric acid, and well washed. If the acid be added with the bleach, the action is quicker. It is then acted on in the cold by about a tenth of its weight of sodium carbonate for twenty-four hours, then heated, filtered, and evaporated. The residual cellulose is pressed into cakes for use as a paper material. It is already bleached, and has only to be put at once into the paper beater. There are plenty of fibrous materials in the market, but there is no real substitute for rags, as, I believe, this will, to a great extent, prove to be.

* This specimen was abnormally low in salts.

The whole of the plant is thus accounted for; in the laminaria the average yield is as follows:

On the air-dried plant—

Extracted by water	30
Extracted by acid	5
Extracted by sodium carbonate = algin	35
Cellulose	10
Moisture	20
	100

This plant is the only one now employed in making kelp; the least exposure to rain washes out the salts, and renders it useless for this purpose. It does not, however, interfere with its use for extracting the algin, which is insoluble in water. For this purpose, if the salts are sacrificed, it is improved by exposure to rain and light. The wet weed, however, keeps perfectly well if access of air be prevented, for instance in a properly constructed "silo," and there is no reason that any of it should be lost.

Applications of Algin.

Algin has properties which should make it useful for several applications in the soluble form. As a stiffener of fabrics, although not so rigid as starch, it fills the cloth better, is tougher, more elastic, and more transparent. It mixes in all proportions with starch and dextrine, and imparts to the mixture these properties. Unbleached, it forms a cheap material for dressing winseys and such dark goods. Passed through an acid bath, the coating becomes glossy and insoluble, and thus a vegetable mordant is available for dyeing. Lime-water and salts of calcium, barium, and several metallic salts, may be employed for a similar purpose, one of its peculiarities being the ease with which it is rendered insoluble.

I shall only just refer to its probable value as a food material on account of its nitrogenous character, as I have no edible specimens on the table which can be passed round for immediate consumption. As a cattle food there is a large opening for such a material. The agglutinating power of algin enables us to convert into solid blocks many substances which are with difficulty made to cohere. Silica, lime, magnesia, oxide of zinc, phosphate of lime, alumina, chalk plumbago, charcoal, and many other such substances can be converted into solid, hard blocks. All of these and many more are exhibited. Some of these compounds may be made by mixing the algin with a solution, where both form a joint precipitate with another solution —*e. g.*, sodium silicate and calcium chloride. One application of this agglutinating character has already assumed importance. Charcoal has been long known as our best solid non-conductor of heat, and no doubt it would have been employed long ago as a covering for our steam-boilers had any medium been known capable of agglutinating it. That is now attained by this substance. My "carbon cement," for this purpose, contains ninety-seven per cent. of charcoal, three per cent. of algin being sufficient to make it cohere; and as that charcoal is made from seaweed, it is a remarkable fact that the whole covering is derived from that material. My friend Mr. Spiller, a high authority on the subject, has also found the solution of algin the best thing yet discovered for arresting incrustation in steam-boilers. We are not much troubled with this in Glasgow, but in the South, where the waters are hard, many such fluids are employed. Most of these are organic compounds combined with alkalies. One of the earliest and best was introduced some years ago by Mr. Spiller himself, and I am entirely indebted to him for suggesting the application of algin to this purpose. He speaks of it as highly efficient in precipitating the lime in such a fine state of division that it can easily be blown off from the cock. So that we now propose sea-weed in one form or another as a most comfortable internal and external application to our steam-boilers. In fact, several large steamers are already plowing the ocean, assisted in their conflicts with heavy seas by weapons borrowed from these opponents.

The insoluble form of algin is very like horn, and as it can be pressed into moulds of any size it may be used instead of that article.

It also appears to be an excellent non-conductor of electricity, and in combination with certain other substances may assist in providing the cheap non-conducting material, which may be impervious to moisture, now so much required for underground telegraph and telephone wires.

It is an efficient agent for emulsifying oils, and, being coagulated by alcohol, for fining wines and spirits.

These are some of the probable applications of algin, and, seeing that the substance is new, and the source abundant, I shall not be bold enough to predict what it may *not* be used for.

[New England Farmer.]

TRANSPLANTING TREES IN JAPAN.

Before transplanting trees, two pieces of paper or cloth are tied to the branches on the east and west, or north and south sides of the tree, so that it may be planted as it stood before in relation to the sun. Particular care is taken in removing the tree. Large roots which extend so far into the ground that it requires a great deal of labor to dig them out are cut off at certain points, either by the saw or any other cutting implements, fibrous roots being carefully protected. The spot where the tree is to be planted is dug a little larger than the roots absolutely require. If the tree is large, two or four strong posts or stakes of convenient size and length are set about it before digging, and are connected by one or more horizontal slats. The stem of the tree is wrapped in straw matting, and tied firmly to the horizontal slats. Where two horizontal slats are used they are fixed to cross each other at the point where the stem is tied. The tree is thus in a suspended condition, therefore, though we dig around the roots quite deep, it may not only be prevented from falling down, but its fibrous roots, which would otherwise be injured more or less by the heavy pressure of the whole tree, can be saved to a large extent.

After having removed the tree to the desired place, particular care is taken in covering the roots well, and also in watering, especially if the soil is rather light. Press the dirt, which is thrown into the hole a little at a time, firmly around the roots, taking care at the same time to set them in their natural position as far as possible. On the contrary, if we throw in dirt upon the roots all at one time and carelessly, all the roots, large and small, are crowded together in one mass, many of which will be injured, even if the tree is not killed. This is especially true of those trees whose roots are rather stiff, as, for instance, the persimmon tree. After the tree is planted it is examined from all sides to see that it has been planted straight, and then it is tied to three posts which are so set about it as to protect it from the wind. The

tree is generally planted not as deep as it stood in the previous place, but earth is heaped around it to some extent above the level of the ground, it being believed that by thus doing the roots may get more warmth than they could otherwise.

February is generally considered the best time for transplanting trees in Japan, though some hold the opinion that November is better than any other month for that purpose. As a general rule, however, it is believed that any tree may be safely transplanted just at the time when its leaf buds begin to show a little green color. Other things being equal, never transplant trees behind the proper season, though the earlier planting may do no harm to the plant. After planting make a sun screen, which should be taken away rainy or cloudy days. At planting watering is considered important. Spreading a little wheat bran on the bottom of the hole before planting the tree is said to make it grow vigorously.

S. ARAKAWA.

CURIOUS ABYSSINIAN TREES.

WE present sketches by the Spanish traveler, Mr. Abargues de Sosten, of two specimens of trees, seen by him in

THE UMBRELLA TREE.

Central Africa, which are notable for their peculiar originality. One of these, named *Acacia mimosa*, is very abundant both on the plains and in mountainous regions. It is specially distinguished by the form of its branches, which rise obliquely from the ground, and its scanty leaves at the top are tenaciously woven together like an awning and presenting the appearance of an enormous umbrella. These trees attain a height of about ten feet, and give a very agreeable shade.

The tree called *Baobab dima* is still more curious. It has

THE WATER BARREL TREE.

a very thick trunk, perfectly smooth, of dark brown color, resembling the hide of an elephant, on account of which some naturalists call it *Paquidermo vegetal;* its branches are thick, short, bent inward, and during only a few days in the year they send out a few small leaves, which the sun soon dries up.

The specimen shown in our engraving, says *La Ilustracion*, of Madrid, was found growing on the right bank of the river Jacazé, and when measured by De Sosten its height was 25 feet, circumference of trunk three feet above ground, 22 feet. Its bark was not only smooth on its surface, but soft to the touch and with few indentations.

The peculiarity of the *Baobab dima* is that its great trunk should be hollow, while in its interior it holds, for many months, water which it absorbs during the rainy season.

EDWARDSIA GRANDIFLORA.

IT was brought to England from New Zealand upward of a century ago, and formed the subject of a colored illustration in the *Botanical Magazine* as far back as 1791. We therefore cannot do better than reproduce the note that appeared with this plate, which runs as follows: "This magnificent and highly curious species is one of the many plants discovered by Sir Joseph Banks in New Zealand, where it forms a tree of considerable size. A finer sight can scarcely be imagined than a tree of this sort extending to a great breadth on a wall with a western aspect in the Apothecaries' Garden at Chelsea, where it was planted by Mr. Forsyth about the year 1774, and which at this moment (April 28, 1791) is thickly covered with large pendulous branches of yellow, almost golden, flowers. They have a peculiar richness which it is impossible to represent in color. In winter care is taken to cover it carefully with mats lest it should suffer from any extraordinary severe weather." Its chief requirements are a warm, sunny wall, protection from excessive cold in winter, and a good loamy soil, rather stiff than otherwise, so as to induce it to form short-jointed shoots, which, if well ripened, will be sure to flower the succeeding season. There are several other species belonging to the genus Edwardsia, but we believe there is but one other in gardens besides E. grandiflora, viz., E. microphylla, which bears smaller and more slender foliage, and not such large and showy blossoms. This used to be grown against a wall at Kew, and though the plant rarely flowered, its elegant foliage had a pretty effect.—*The Garden.*

FLOWERING BRANCH OF EDWARDSIA GRANDIFLORA (FLOWERS YELLOW). SKETCHED IN APRIL FROM A PLANT GROWN AT COOLHURST, HORSHAM.

MATTE IN BRAZIL.

THE poorer class of houses are coarsely built of clay supported in a framework of poles and thatched with rushes. The standard articles of food are jerked beef and beans, but *matte*, or Paraguay tea, is found in every house. This beverage is extensively used throughout the southern part of South America, and it is so important that I will describe its preparation somewhat at length.

The matte plant (*Ilex paraguaiensis*) grows in the high forest of the region between the Parana and the Atlantic, and perhaps also in the Matto Grosso. It is a shrub or bushy tree from ten to twenty feet high, and thickly covered with oblong-lanceolate leaves, which are furnished beneath with peculiar aromatic glands. The *hervaes* are commonly in mountainous districts, far from settled places, and the peasants make long journeys to gather the leaves. Having chosen a locality, they go over it in detail, hacking off all the smaller boughs, and leaving only the stems and lower parts of the main branches. Soon after gathering, the boughs are passed, one by one, through the flame of a long fire bed with certain aromatic woods; this operation lasts only half a minute for each branch, but it requires a peculiar dexterity not easily acquired; an unpracticed hand will burn the leaves or dry them unevenly. After this preliminary scorching the branches are cut into smaller portions, which are gathered into fagots and hung close together under a low shed; there a fire is maintained under them for twenty hours or more. To secure good matte this fire should also be fed with aromatic woods, which give a bright flame without smoke; the workmen, however, frequently use the first wood which comes to hand, such as the *araucaria*, or Brazilian pine, which imparts a disagreeable odor to the leaves. Being thus thoroughly dried the fagots are allowed to remain under the shed until the time arrives for sending them to the factory; they are then untied, and the twigs are strewn over a clear space of hard ground, which has been previously prepared; here they are thrashed with long poles until the leaves and twigs are reduced to small fragments. The mass is then gathered up and packed in baskets for transportation. Commonly the gathering is repeated at intervals of five or six years in each *herval*, and the product of a tree is said to be better after it has been despoiled several times. The first cutting may take place when the tree is fifteen years old. Sometimes the leaves of other species of Ilex are mixed with the true matte, to its great detriment. Attempts have been made to cultivate the tree, but without success; the seeds grow naturally only at intervals of several years, and under peculiarly favorable circumstances. It is said that germination takes place only in those seeds which have passed through the intestines of birds.* If this be true, the fact will be an important addition to the large mass of evidence which tends to show that plants are intimately dependent on animals for their propagation. At all events it is certain that the Jesuits of Paraguay formerly utilized the bodies of their Indian servants to induce germination of Ilex seeds for their plantations.

Arrived at the factory, the leaves, if damp, are again dried by exposing them for several hours to gentle heat in a furnace or oven. The woody portions are then picked or sifted out, and the leaves are reduced to finer fragments in mortars. The commercial quality of the matte depends mainly on the thoroughness of the last two operations, but somewhat, also, on the region from which the leaves are gathered, nearness to or remoteness from the sea, and the skill and care shown in the drying operations. Paraguay *yerba* is perhaps the best, but that country furnishes only one-fifth of the matte which is consumed in South America; at least three-fifths is produced by the Brazilian province of Parana, the remainder coming from Santa Catharina and Rio Grande do Sul.†

No South American thinks of drinking matte from a cup; it is taken from small globular or oval gourds, which are often prettily painted or carved, and sometimes elaborately ornamented with silver. The gourds are half filled with the leaves, sugar being sometimes added; boiling water is then poured in, and the infusion is sucked through a tin or silver tube, the end of which is furnished with a perforated bulb. The same leaves serve for several infusions. Among the Rio Grande peasants the *cuia* and *bombilha* handed to a traveler are the first mark of hospitality; when he has sucked the liquor out, the gourd is filled with water again, and passed to the next guest, or, in his absence, to a member of the family. Commonly the same gourd and bombilha complete the circle two or three times before they are finally laid aside.—*H. H. Smith, Amer. Naturalist.*

* Couty: Le Mate et les Conserves de Viande, p. 17. In this work a very complete account is given of the preparation of matte.

† I have described the preparation as it takes place in Rio Grande; it differs somewhat in the other provinces and in Paraguay.

PROGRESS OF NICKEL METALLURGY.*

By William P. Blake.

The metallic element nickel, discovered by Cronstedt the mineralogist in the year 1751, as a peculiar metal in kupfer-nickel, remained for a long time comparatively unknown in its true characters. It was at first obtained as a secondary or by-product, in the manufacture or extraction of cobalt, being found concentrated in the cobalt speiss left in the pots when smalt or cobalt-blue glass was manufactured. Cobalt at that time was the product chiefly sought, and nickel in its applications was unknown. Since the discovery of the artificial ultramarine blue, the demand for cobalt has been lessened, while the increasing uses of nickel have made it of first importance, and the conditions are thus reversed.

But the nickel so produced from the residues was contaminated with copper, iron, or arsenic, and in this condition it entered into the composition of the familiar alloy commonly known as German silver, but properly known as nickel silver.

The so-called nickel or nickel bronze was a complex, irregularly constituted alloy, in which less than one per cent. of arsenic was sufficient to greatly modify its physical properties. And it was difficult to free the metal from this element. It may be said that until within a few years the element nickel, in its true characters and in a comparatively pure condition, was commercially unknown.

To the scientific chemist, however, its true physical properties early became known, though not without some contradictory and varying results, at first resulting no doubt from minute differences of composition of their samples according to the nature of the processes employed for the extraction of the metal. Richter found that nickel oxide strongly ignited in an earthen crucible with carbon gave the metal in a perfectly malleable, ductile condition. It could be hammered cold or hot into plates one one-hundredth of an inch in thickness, and could be drawn into wire one fifty-sixth of an inch in diameter.† Its malleability was found to be diminished by carbon or manganese. On the other hand, Tupputi found that nickel reduced in the presence of carbon in a covered charcoal crucible and under glass, formed more or less nickel-graphite, absorbed a portion of carbon, and was less ductile than zinc. It was brittle when cold, and was as fusible as cast iron (Erdmann), while the metal obtained by Richter was difficult of fusion. He also noted that nickel could be welded, but Tourte found that it welded but imperfectly.

Deville cited cobalt and nickel as metals with useful physical properties but little known, such as malleability, ductility, and a tenacity surpassing that of iron. He showed that these metals could be worked at a forge with the same facility as iron; that they were susceptible of being employed in the same manner, and were less oxidable.‡

Inasmuch as nickel first became known commercially in the industrial arts in the form of an alloy, there were no special attempts to produce the metal in a state of extreme purity. The nickel silver of commerce answered all the existing demands, and was of course much easier to make, and cheaper than the pure nickel. It found a large and rapidly extending consumption as a substitute for silver spoons and forks and for silverware generally, especially when the new art of electro-plating was developed by Spencer, Smee, and others. The nickel silver was specially well adapted to receive and hold the deposit of silver, and it is to this day the most desirable alloy for plating.

The use of nickel alloy for small or subsidiary coins next made an increased demand for nickel. Tentative efforts were made by Dr. Feuchtwanger, in New York, in the year 1837, and he actually issued many small one-cent and three-cent pieces, made of a nickel alloy, the exact composition of which he was careful not to state, but called it "Feuchtwanger's composition." Switzerland commenced using nickel alloy coins in 1850; the United States in 1857, though sample coins, one-cent pieces, had been made by Prof. James C. Booth, at Philadelphia, in 1853, the prepared alloy containing from 5 of nickel and 95 of copper to as high as 30 of nickel and 70 of copper. The alloy adopted by law consisted of 12 of nickel and 88 of copper. The five-cent pieces now in circulation are made of an alloy of 25 parts of nickel and 75 parts of copper. In 1860, Belgium adopted an alloy of the same proportions, for small coins. Other countries have followed, until the use of nickel alloy for small coins may be said to be almost universal in the chief commercial countries. Up to June 30, 1876, the United States had alone issued of the five-cent nickel to the extent of $6,716,129 in value. Another sudden demand for a larger supply of nickel sprang up when the art of depositing nickel by electricity was perfected. The many and increasing applications of this art need not be here enumerated. It is sufficient to state that at the present time they constitute a large part of the present consumption of the metal in this country, where the art may be said to have originated in a successful, practical form.

Nickel ore is more generally distributed throughout the mineral-bearing portions of the United States than is generally supposed. It is commonly associated with chrome ores from Canada to Maryland, on the Atlantic side, and equally with the chrome ores of the Pacific slope, notably in Oregon. It is also a common associate of magnetic pyrites in the Archæan rocks, being found in Litchfield County, in Connecticut; in the Highlands of the Hudson, in New York, and in New Jersey; and especially at Lancaster Gap, in Pennsylvania, where the chief supply of nickel has been obtained for the United States. This ore yields from 1½ to 2 per cent. of nickel, but is enriched by smelting at the mine into a matte containing 10 per cent. or more of the metal. This locality was worked some thirty years ago by Prof. James C. Booth and others, of Philadelphia, and some nickel alloy was made. Some ten years later Mr. Joseph Wharton purchased the works, and established the industry at Camden, N. J., opposite Philadelphia, where it has since been carried forward.

A large portion of the metal produced at these works by Mr. Wharton has been used at the United States mint for the subsidiary small coins, and a considerable amount has been exported. Since the development of nickeling by galvanism, a large part of the product has been put into the form of nickel salts and anodes.

But Mr. Wharton, not being content with the production of impure nickel, early commenced experimenting to determine whether nickel could not be produced in a pure and malleable condition, susceptible of being worked in nearly the same manner as iron, and of being applied in the manufacture of various objects requiring strength of material and a material that cannot be easily oxidized. One of his earliest experiments was to take the somewhat spongy mass got by reduction of the oxide of nickel, and after heating it to full redness, work it under a steam-hammer into a bar.

In 1873, Mr. Wharton sent to the Vienna Exhibition a sample of nickel in the form of axles and axle bearings, and at the exposition in Philadelphia in 1876, he exhibited a remarkable series of objects made of *wrought nickel*, such as bars, rods, a cube, a horse-shoe magnet, and magnetic needles of forged nickel. These did not excite the interest to which they were entitled as a remarkable advance in the working of this little known metal. The exhibit did not cause much comment, and it was not specially described or reported upon, so far as I am aware, except by the judges who reported the exhibit to the Commission as worthy of an award in the following terms: "A fine collection of nickel ores from Lancaster County, Pa., with nickel-matte, metallic nickel in grains and cubes, and manufactured nickel, both cast and wrought; nickel magnets and magnetic needles, cast cobalt, electro-plating with nickel and cobalt, and salts and oxides of both these metals; the whole showing a remarkable degree of progress in their metallurgical treatment."*

Some of the same objects formed of wrought nickel were sent over to Paris two years later, and were exhibited in the American section in 1878. There, as in Philadelphia, they did not at first excite any surprise, or receive any special attention. Very few persons realized what the objects really were, and that they were very different from *alloys* of nickel. In fact, very few chemists had ever seen *nickel*. Pure nickel was a rarity, a curiosity, just as samples of indium or thallium are to-day.

You can then, perhaps, imagine the incredulity of the expert chemists and metallurgists of Europe, when whole ingots and forged bars of metal and numerous finished articles of pure wrought nickel, without alloy, were offered for their inspection. These articles not differing greatly in their appearance from the higher grades of nickel alloys, or from electro nickeled objects, they passed them without surprise. No previous exhibition had been so rich in exhibits of the use of nickel and in the products from them. The influx of the pure carbonated and oxidized ores from New Caledonia had greatly stimulated the nickel industry in Europe, and had improved the quality of the alloys of nickel. New companies had been formed to manufacture nickel silver and to produce nickel from these superior ores at a lower cost than had before been possible. Christofle, of Paris, had just erected extensive works at St. Denis, and had made a most brilliant display of his products in one of the main avenues of the Exposition. The Vivians, of Swansea, and other exhibitors had large cases filled with beautiful objects of hollow and solid ware made of nickel silver.

Amid these various exhibits of striking *tours de force*, the modest little showcase from the United States with examples of manufactures of *pure wrought nickel*, not alloy, could hardly be expected to excite attention and win the golden award, which was most cheerfully accorded as soon as the fact was demonstrated by analysis that the objects were really of the pure metal. Some of the objects now shown were at that exhibition, and have retained their brilliant polish and luster unimpaired. These notable advances in the metallurgy of nickel, made with the lean and sulphureted ores of Lancaster Gap, prepared the way for greater advances.

Dr. Fleitman, of Iserlohn, Westphalia, Prussia, has improved and cheapened the operation of refining the nickel and toughening it, and has reduced the liability to the presence of blowholes in castings by adding to the molten charge, in the pot, when ready to pour, a very small quantity of magnesium. This is immediately decomposed, magnesia is formed, and graphite is separated. It would seem that the magnesium decomposes the occluded carbonic oxide, or reduces it to a minimum. The magnesium must be added with great care, and in small portions, as it unites explosively with the charge. It is stirred in. About one ounce of magnesium is sufficient for 60 pounds of nickel. Three-quarters of an ounce to 54 pounds of metal has been used with success by Mr. Wharton. The nickel from the ore at Lancaster Gap seems not to require as much as the foreign metal. It is to be noted that complete malleability of nickel was obtained at Wharton's works, in Camden, before Fleitman's invention or process, but this last is more rapid and better than the old method. The metal so treated becomes remarkably tough and malleable, and may be rolled into sheets and drawn into wire. Cast plates can be successfully rolled. The cast plates, such as are made for anodes, after reheating, are rolled down to the desired thickness. It is found that it is a great improvement to the nickel anode plates to roll them down. They dissolve with greater uniformity in the bath. Nickel so treated with magnesium has been rolled into sheets as thin as paper.

Expensive works for rolling the metal have been erected by Mr. Wharton, at Camden. There is already a train of 40 inch rolls, 18 inches in diameter, with annealing ovens and gas furnaces and their adjuncts, and a 90 horse power engine. At present this mill as well as the works for producing the metal, and the mine also, are "shut down."

The largest sheet yet rolled at Camden was 72 inches long and 24 inches wide, of pure nickel.

Dr. Fleitman has also succeeded in welding sheet nickel upon iron and upon steel plates, so as to coat them equally on each face with a layer of nickel. The quantity preferred by weight is eight-tenths iron and two-tenths nickel, one-tenth of nickel being placed on each surface. To secure union the iron or steel must be perfectly flat and clean. A pile is made with outer facings of sheet iron to protect the nickel from scaling. When the whole is heated to the proper degree, it is passed through the rolls. The two metals become so firmly united that they may afterward be rolled down, two or three together, or separately, to the thinness desired.

The samples exhibited were cut from sheets made at Mr. Wharton's works at Camden. One sample No. 20 gauge, 10 per cent. nickel; one sample No. 20 gauge, 10 per cent. nickel; one sample showing edge of sheet.

These are all examples of nickel upon iron. I also show a thin sheet of pure nickel annealed. The physical properties of the two metals iron and nickel are so nearly the same that they work well together. The nickel surface cannot be removed or regained in the scrap and waste except by dissolving out the iron core by dilute sulphuric acid. In the earlier experiments, the ingots or cast plates were beaten under the hammer; this produced a great deal of scale and waste, as with iron, but this is now avoided, partly by the device of a thin covering of sheet iron which is afterward dissolved off. Dr. Fleitman claims to have produced steel wire similarly coated, and proposes to make nickeled boiler plates.

The applications in the arts of such nickeled iron sheets as I have described will readily suggest themselves. Up to this time the most direct uses seem to be in making hollow ware, particularly culinary vessels. The manufacture has already begun at Schwerte, by Dr. Fleitman, and a great variety of vessels, such as saucepans and kettles, have been turned out, some of them of pure sheet nickel. They are all very beautiful in appearance, resembling highly finished platinum vessels more than ordinary ware. When planished and buffed off, the surface becomes like a mirror, and will answer the purpose of one. The small vessel exhibited is made of nickeled iron, and will show the facility with which the compound sheet metal may be stamped, spun up, and polished. Much larger specimens of ware might be shown.

This ware is believed to be far superior to tinned iron or tinned copper for cooking in. The nickel is not only less liable to corrosion, but is harder, will wear longer, and cannot be melted off by overheating. The ware is lighter and stronger than tin or copper ware; is susceptible of a high polish and is not easily tarnished. It appears to be well adapted to the manufacture of dishes, salvers, and covers for the table. The coating of nickel applied by welding is stronger and tougher than that deposited by electrolysis, and appears to be less liable to scale off. The electrically deposited metal is in some cases very brittle, and no doubt contains sufficient hydrogen to essentially modify the physical characters of the coating.

* From a paper read at the Boston meeting of the American Institute of Mining Engineers, Feb., 1883.

† Cited in Gmelin, v., 381.

‡ Comptes Rendus de l'Académie.

* Reports and Awards, Group One, 640, p. 470.

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